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Oldest Irrigation Conduit and Dam in the United States

On the meadows beside the lower San Diego River, half a dozen miles northeast of the City of San Diego, is the old San Diego mission. Here the Catholic missionaries, working northward from Mexico, established near the end of the eighteenth century one of the first outposts of civilization on the Pacific Coast in what is now United States territory.

In this arid region, with a rainfall averaging only about a dozen inches per annum, all occurring in the fall and winter months, irrigation is a prime necessity to agriculture. There still stand in a remarkably good state of preservation the dam and a large part of the conduit by which water was diverted from the San Diego River and carried some miles down its valley to the ranches surrounding the mission. There is little doubt that this dam and conduit are entitled to the distinction of being the oldest irrigation works in the United States, with the exception of course of the more or less primitive works for irrigation carried on by Indian tribes prior to European settlement. When one bears in mind the extreme limitations in means of transportation, in material, labor, and money with which these Catholic pioneers had to contend, the building of the old Mission dam and conduit was a remarkable achievement.

The dam, it should be explained, is purely a diverting dam and not a storage dam. The San Diego River in its course of some 50 mi. descends from elevations of 3,000 to 5,000 ft., and the river and its tributaries have eroded deep cañons in the soft rocks of the region. At its flood stages the river carries a very heavy burden of sand and silt, so that the pond back of any dam built across it is filled full with solid material during the first flood season.

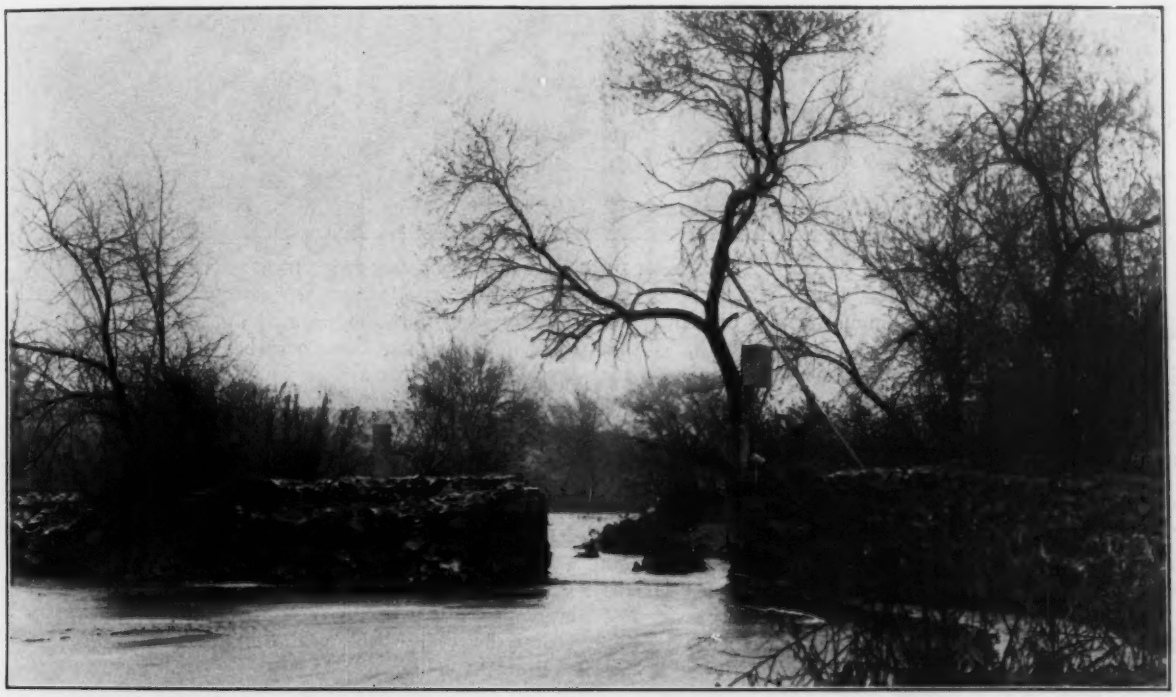

FIG. 1. THE OLDEST IRRIGATION DAM IN THE UNITED STATES, BUILT BY THE OLD MISSION OF SAN DIEGO, CALIF.

It is of interest in this connection to record that prior to 1850 the San Diego River carried annually vast quantities of silt into San Diego Bay and was rapidly filling up the present harbor of San Diego. It was due to the genius of a distinguished officer of the Corps of Engineers that San Diego harbor was saved for commerce. During the years prior to the Civil War, Lieut. Geo. H. Derby, of the Corps, who was stationed on the Pacific Coast, made himself famous by writing humorous papers which were published under the *nom de plume* of John Phoenix. Lieutenant Derby proved that he was as com-

FIG. 2. VIEW OF OLD MISSION DAM DURING A FLOOD IN THE SAN DIEGO RIVER

petent an engineer as a humorist by diverting the course of the San Diego River at its mouth, so that instead of discharging into San Diego harbor it was made to empty into what is known as False Bay, a shallow body of water located to the north of San Diego Bay and separated from it by a high sand ridge.

The old Mission dam and the conduit, as may be seen by the accompanying illustrations, were built of a curious combination of rough rubble masonry and very large, thin tile. The mortar used was of course lime mortar and must have been burned in kilns established for the purpose near-by. As may be judged from the views of the dam and of the flood which it annually sustains, this lime-mortar masonry has lasted remarkably well. The central opening in the dam, seen in the view, doubtless originally contained a wooden controlling gate which was left open in time of flood and was closed only when it was desired to divert the water into the irrigation conduit, which connected with the dam near its north end.

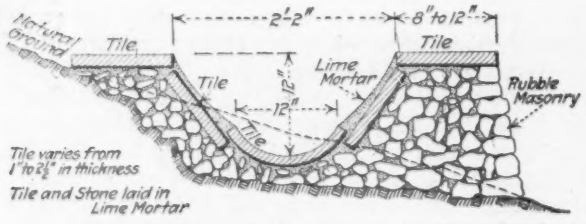

FIG. 3. TYPICAL CROSS-SECTION OF OLD MISSION CONDUIT NEAR SAN DIEGO, CALIF.

One reason for the location of the dam at this point is that the river here flows over bedrock at the head of a long cañon, so that all the flow down the valley is intercepted by the dam. In recent years the dam has been used as a river-gaging station by the United States Geological Survey.

From the dam the masonry conduit follows down the north bank of the river about three or four miles to the lands around the old mission. Much of the conduit is still plainly visible from the highway on the opposite bank. The construction of the conduit is shown in the accompanying cross-section drawing. Over a part of its course, however, the conduit was in excavation and appears to have been merely lined with masonry. The size of the tiles used for lining is particularly noteworthy and evidences the considerable ability of these early pioneers in the art of pottery manufacture and in utilizing Indian labor for this more or less technical work.

Engineering News is indebted to F. M. Faude, Assistant Manager of the Cuyamaca Water Co., for the accompanying photographs and cross-section drawing of these old irrigation works and for courtesies extended to a member of the editorial staff on a visit to them.

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The Expenses of the City Engineer's Department of Providence, R. I., for the year ending Sept. 30, 1915, so far as shown by bills actually paid, were distributed as follows: Salaries of city engineer and assistant engineers, $52,516; salaries of clerks, $4,705; supplies, including drawing materials, $3,016; carfares, $1,517; instruments and repairs, $334; telephone lines, $238; sundries, $22; meteorological instruments and repairs, $10; carriage hire, $6; total, $62,374.

County Engineering in Kansas

EDITORIAL CORRESPONDENCE

The present road and bridge laws of Kansas (passed in 1909) are so deficient that the position of county engineer is anything but an easy one. The difficulties of this office have been discussed at several annual meetings of the Kansas Engineering Society, and at the most recent one the county-engineer members of the society formed a committee, or organization, to seek remedial legislation.

While the present law establishes the office of county engineer (optional with the county) and defines his duties as the general supervision of road and bridge work, the actual effect of the various provisions is to make him entirely subordinate to the county commissioners, who may or may not follow his advice and directions and who may at any time dispense with his services altogether. With tact and popularity the engineer may accomplish something, but these are his only means.

In spite of these drawbacks and the fact that the salaries range from $400 to $1,200 a year, several technically trained young engineers are devoting their best efforts to this work. Their field is a large one, if it is considered that there are 108,500 mi. of highways in the state, all dirt or gravel roads, and that about 0.5% of the area of the state is in streams of various sizes.

The bridges over some of these streams are remarkable creations. If one wishes to see the laws of mechanics defied, let him take a trip over some of these Kansas highways. In the county surveyor's office at Abilene are plans showing recent measurements of three bowstring truss bridges, which have been in service since the seventies. One of these bridges has spans of 168 ft., with approximately 9-ft. panels, but with no two panel lengths the same and with the lengths of opposite panels differing from each other by as much as 6 in. It is impossible to tell whether the bridge was so constructed or whether its members have "stretched." The top chords are of remarkably light section, and the laterals are all rods. These bridges have wood stringers, and the problem is to replace them without adding to the dead load.

The accompanying illustration is another type of bridge quite popular in this county until recently. The farmer who tried to take a traction engine over it had about as much knowledge of mechanics as the farmers who constituted the board of county commissioners that built it. A number of these bridges, however, have been made to serve by riveting two 3½-in. angles to the top chord.

These county bridges have been built under trustee commissioners, appointed by the county commissioners. Such a trustee, or bridge, commissioner must reside in the township, and his duty is (quoting the law) "to proceed to the spot where the bridge is to be built, and make an accurate estimate of the cost according to any plan or plans ordered by the county commissioners, or such as in his opinion may be best." Upon such data bids are advertised and contracts let to the lowest bidder. This bridge commissioner receives the munificent salary of $1.50 per day. The bridge is accordingly built "under the supervision" of a superintendent appointed by the county commissioners, who also receives $1.50 per day.

There is a growing sentiment in the state in favor of a large bond issue (generally put at $25,000,000) for good-roads construction, but it is obvious that the first step is to educate the farmers to the value of engineering service and advice. Since the townspeople of Kansas are already so progressive that there is not a city of over 1,000 population without water-works, none of over 2,500 population without a sewer system and many cities under 1,000 population with paved streets, the time is probably not far distant when there will be good county roads and bridges as well.

The rocky pathway of the county engineer under the present system is aptly summarized as follows in a paper by R. F. Gallup, county engineer of Marshall County:

> The engineer's success will depend not only upon his technical and practical training, but also in a measure upon his ability to solve the human equation. No man liveth to himself alone, and certainly not the engineer, whose work is almost entirely connected with the public welfare. From day laborer in the foundation pit to the head of a bridge company, from road boss to county commissioner or mayor, he will be alternately commended and censured, and he must keep his equilibrium through both praise and blame. The progressive man will be quick to profit by helpful criticism, no matter from what source it comes, and then knowing himself to be right, go ahead. Diplomacy is necessary, but not to the extent of being wafted about by every breeze of public opinion. He must carry a "gentleman's manner with a rhinoceros' hide."

A KANSAS COUNTY BRIDGE TESTED BY A TRACTION ENGINE

Making and Laying Home-Made Pipe for Water Mains

Plymouth, Mass., has the practically unique distinction of manufacturing all the pipe which has been used for its water mains. The policy of using exclusively sheet-iron or sheet-steel cement-lined pipe was adopted many years ago (in 1855) and has been followed consistently ever since. In 1900 the town water department built a specially designed plant for making this pipe as a part of its water-works routine.

Plymouth has a comparatively small population (about 12,000), and the water pressures are not high—from 30 to 70 lb. per sq.in. While the water-works superintendent does not by any means recommend the universal use of cement-lined, sheet-steel water-mains, there seems to be no question of its satisfactory service and economy in Plymouth. It is not unlikely that in many localities where freight rates on cast-iron pipe make it almost prohibitive, home-made cement-lined pipe would be a simple and economical solution of the distribution-system problem.

The original pipe, of which there is still a large amount in use, consisted of a sheet-iron shell about 9 ft. long, lined on the inside with about ½ in. of cement mortar mixed 1:1. The pipe was laid on a bed of mortar in the trench with the ends simply butted together and covered with a steel sleeve, or collar, afterward incased in mortar. The top and sides of the pipe were then covered with 2 in. or more of mortar, all of the same proportions as the lining—1:1 cement and sand. A part of one of these mains which had been in continuous use for 60 yr. was dug up Oct. 4, 1915, in the presence of one of the editors. It was in perfect condition inside and out.

Method of Manufacturing Cement-Lined Pipe

The water-works shop built in 1900 is equipped with machinery and facilities for making pipe according to the Phipps patented method. Since then, mains up to 30 in. in diameter have been manufactured. This new pipe consists of a shell, a jacket, male and female end rings and sleeves. The shells and jackets are made of rectangular plates of soft steel, the gage depending on the diameter of the pipe. For 24-in. pipe the gage is 12; 18-in. pipe, 13; 16-in., 13; 12-in., 15; 10-in., 17; 8-in., 18; 6-in. 19; 4-in., 20. The jackets are all of 26-gage wrought iron.

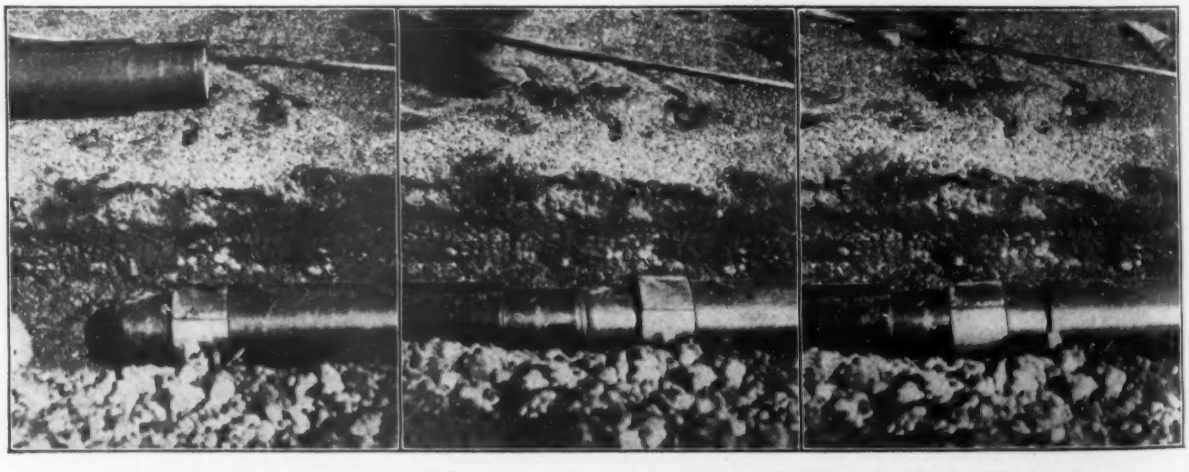
FIG. 1. A "SPECIAL" OF CEMENT-LINED SHEET-STEEL WATER PIPE

The plates for the shell are punched in a machine which makes the two rows of holes simultaneously. The holes are spaced ¾ in. c. to c., the edge of the holes being ⅝ in. from the edge of the plate. When the punching is completed, the plate or plates (two for the larger sizes of pipe) are bent to the approximate radius required, by running them through steel rolls. The plates are then riveted together by hand on a bench, or "stake," the top of which is shaped to approximately the curve of the interior of the pipe. The jacket plates are handled in the same manner, making cylinders 1½ in. larger in diameter than the shells.

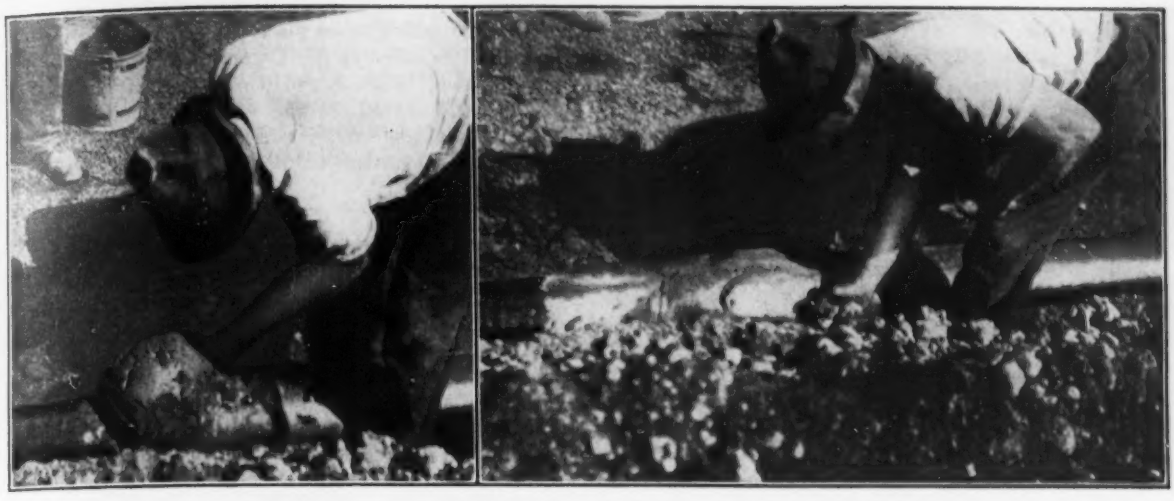
The end rings are of the best grade of cast iron; a male, or convex, ring is driven into one end of the shell and a concave, or female, ring into the other end. The thickness of the ring castings on the inside of the pipe is the same as that of the cement lining.

Lining the Shells with Cement Mortar

The lining of the pipe is accomplished by a simple machine, the essentials of which are an elevator and a revolving cylinder, or since it is slightly tapered, a "cone." The shell is placed on the elevator platform over the pit containing the cone, the top of which ex-



FIGS. 2 TO 4. STEPS IN MAKING THE JOINT IN CEMENT-LINED SHEET-STEEL WATER MAIN



FIGS. 5 AND 6. COVERING THE JOINT WITH NEAT CEMENT MORTAR

tends into the shell far enough to prevent the mortar lining from falling through. The mortar is mixed on the floor above by machine. It is made of neat Rosendale cement and water. The cone is started revolving, and the batch of mortar is dumped into the top of the pipe shell, which is then lowered on the elevator over the revolving cone. The elevator is raised again, the pipe removed and the rough places and final finish given by hand tools.

When the cement lining has properly set, the shells are stood on end alongside an elevated platform and the jackets placed over them. A special clamp is used to hold the bottom of the jacket, and four wedges hold its top in place. The space between the jacket and the shell is filled with a very wet grout of neat cement. The mixing is done on the same machine as for the lining, and the grout is conveyed in a traveling steel bucket. The pipe is then allowed to stand for 24 hr.

Making Joints—Tests of Old and New Joints

When properly cured, no difficulty is experienced in handling the pipe. It can be rolled off a wagon without injury. In laying the pipe the end rings are wedged together as tightly as possible. The joint is then plastered over with mortar, and a sleeve of the same gage iron as the shell is pushed over the connection. The whole connection is then plastered over with two or more inches of neat cement mortar (see accompanying illustrations, especially Figs. 5 and 6.)

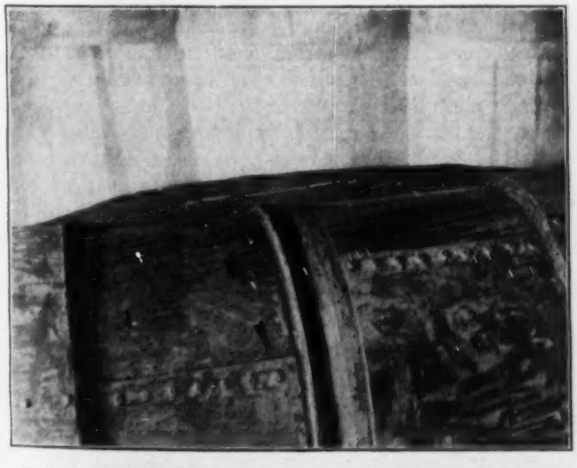


FIG. 7. COMPLETED JOINT IN CEMENT-LINED MAIN WITH CONCRETE COATING REMOVED

Tests of a 50-yr.-old 10-in. main 7,500 ft. long have shown a leakage of 9,550 gal. daily, or 4.4 gal. per lin.ft. of joint per day. Tests of a 25-yr.-old main 9,300 ft. long, half of it 16 in. and the other half 14 in. in diameter, have shown a leakage of 2.3 gal. per lin.ft. of joint per day. The joints are undoubtedly the weakest part of the old-style pipe, but tests of new joints in the new type of pipe show very little leakage under testing pressures of 150 lb. per sq.in.

Cost Data on Cement-Lined Pipe

The cost of making this pipe does not differ greatly from the cost of cast-iron pipe delivered at Plymouth under the prevailing prices. There are times, however, when there has been considerable economy in the cement-lined mains. The soil of Plymouth is dry and sandy, and there is no corrosion from the outside. On the inside of the mains there is never any trouble from tubercles or other incrustations, and the pipe maintains its maximum carrying capacity indefinitely. The loss of head from friction is of course more than in new iron pipe.

The cost of making 16-in. pipe in 1907 was $1.24 per lin.ft., including the joint sleeves. In 1908 the cost of making 7,424 ft. of 18-in. pipe was $10,714.78, or $1.44 per lin.ft. In 1910 the cost of making 8-in. pipe was 52½c. per lin.ft.; 6-in., 38.2c. per ft.; and 4-in., 27.6c. These costs do not include the cost of sleeves for the 4- and 6-in. sizes. The cement-lined pipe is lighter than cast-iron pipe, and the cost of handling and laying is less, if anything, than that for cast-iron pipe.

Records of Maintenance Costs—Making Taps

A record of the mains since 1905 is as follows: There were then 46¾ mi. in use (2- to 20-in.), the number of leaks per mile was 0.87, and the cost of repairs per mile was $11.02. In 1906 there were 47¼ mi. in use, 0.53 leak per mile, and the cost of repairs per mile was $6.67. In 1907 there were 49½ mi. in use, 0.52 leak per mile, and the cost of repairs per mile was $12.56. In 1908 there were 51½ mi. in use, 0.64 leak per mile, and the

cost of repairs was $7.71 per mile. In 1909 there were 52¼ mi. in use, 0.96 leak per mile, and the cost of repairs per mile was $12.43. In 1910 there were 53¼ mi. in use, 0.43 leak per mile, and the cost of repairs per mile was $3.71. In 1911 there were 53½ mi. (2- to 30-in.) in use, 0.03 leak per mile, and the cost of repairs per mile was $3.50. In 1912 there were 54 mi. in use, 0.44 leak per mile, and the cost of repairs per mile was $4.37. In 1913 there were 54½ mi. in use, 0.28 leak per mile, and the cost of repairs per mile was $4.47. In 1914 there were 55¼ mi., 0.25 leak per mile, and the cost of repairs was $2.20 per mile. These figures show a decreasing number of leaks and a decreased cost of maintenance, as much of the older pipe was replaced. The average number of leaks per mile for the whole 10-yr. period is 0.495, and the average cost of repairs per mile is $6.86.

No difficulty is experienced in making taps in this type of water main. The jacket is cut away with a cold chisel, and the intervening cement down to the shell is chipped away in the same manner. Tapping through the shell and lining and the placing of the corporation cock are then performed in the usual way.

The superintendent of the Plymouth water-works is Arthur E. Blackmer.

Lost-Head Diagrams for Bends in Water Pipe

By Ben Moreell*

Numerous formulas for the determination of the hydraulic head lost in a circular bend in a water pipe have been proposed from time to time. These formulas are based either upon a theoretical consideration of the mechanics of the problem or upon the author's "judgment," the latter of which may be classed as mere arbitrary assumptions. The desirability of establishing a uniform standard of practice which shall conform as closely as possible with all of the known facts led the writer into an investigation of this subject. The resulting conclusion was that theoretically there is no loss of head in water flowing around a bend and that any compensation for the loss which is known to occur should be based upon the results of actual experiments.

The first reliable recorded experiments are those of Williams, Hubbell and Fenkell on 12-, 16- and 30-in. water mains of Detroit, Mich., with velocities up to 5.8 ft. per sec. Later, experiments were made by Saph and Schoder at the Cornell hydraulic laboratory, G. J. Davis at the Wisconsin hydraulic laboratory, C. W. Alexander at the University of Birmingham and W. A. Brightmore. These later experiments were performed on 2- to 6-in. pipes, with velocities up to 16 ft. per sec.

We have also a table of constants established by Weisbach, based on the results of his own experiments and those of Dubuat. These constants are to be substituted in the equation

$$lost\ head = C\frac{v^2}{2g}$$

and vary with the radius of curvature of the pipe.

Before entering upon a discussion of the results obtained, it might be well to investigate the "character" of the loss which takes place at a bend. The work of Saph and Schoder at the Cornell laboratory shows this quite clearly. Figs. 1 and 3 show velocity contours in straight and curved portions of a 2-in. brass pipe. Although the average velocity in all cross-sections of a pipe line of the same diameter throughout must be the same $\left(v = \frac{Q}{A}\right)$, it is evident from an examination of Figs. 1 and 3 that the average velocity next to the sides of the pipe in curve-distorted flow is greater than in normal flow, causing a greater loss in head due to friction on the pipe wall. This consideration leads us to the conclusion that the loss of head due to curvature is caused (1) by the resistances produced by distortion in the interior of the stream, causing boils and counter-currents even in a perfectly smooth pipe, and (2) by the increased frictional resistance on the sides of the conduit, due

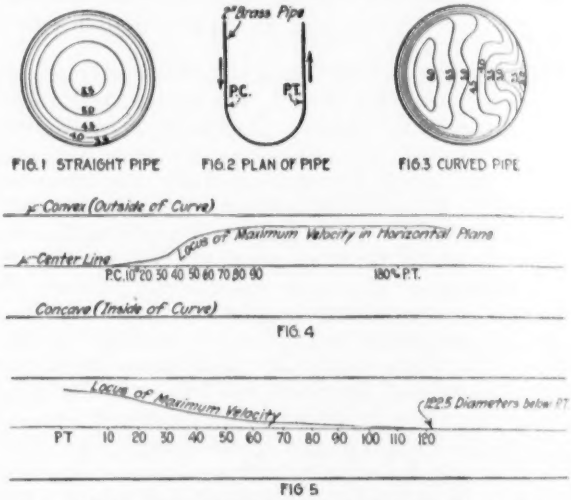

2" Brass Pipe
P.C.
P.T.
Convex (Outside of Curve)
Locus of Maximum Velocity in Horizontal Plane
Center Line
P.C. 10° 20 30 40 50 60 70 80 90
180° P.T.
Concave (Inside of Curve)
Locus of Maximum Velocity
122.5 Diameters below P.T.
PT 10 20 30 40 50 60 70 80 90 100 110 120

FIG. 1 STRAIGHT PIPE FIG. 2 PLAN OF PIPE FIG. 3 CURVED PIPE

FIG. 4

FIG. 5

FIGS. 1 TO 5. EFFECT OF CIRCULAR BENDS ON FLOW OF WATER IN PIPE

to the shifting of the maximum velocity from the center toward the outside of the curve.

Figs. 4 and 5 show the locus of the positions of the maximum velocity in the plane of the horizontal diameter of the pipe. As the water strikes the P. C., the position of the maximum velocity begins to move toward the outside. At 50° from the P. C. it is found that the distortion has practically been completed. There is no appreciable change in the second quadrant, the water having thoroughly adjusted itself to curvilinear motion.

The water, having traversed the curve, enters the downstream tangent under its fully distorted condition (Fig. 5). The equilibrium, however, has been destroyed, and the water gradually adjusts itself to the changed conditions until at 122.5 diameters downstream from the P. T. the condition of normal flow in a straight pipe has been attained. It is thus evident that a considerable portion of the loss due to a bend takes place in the straight portion of pipe downstream from the curve.

In all of the experiments performed, the results seem to indicate that for any given velocity, the lost head in a circular bend of a certain angle is proportional to the radius of curvature of the pipe, the ratio of radius of bend to diameter of pipe, $\frac{R}{D}$. The experiments have all been performed on bends of 90° with various radii.

*Assistant Engineer, City Hall, St. Louis, Mo.

Although it seems reasonable to suppose that the excess loss in a bend would depend in some measure upon the nature of the material of which the conduit is made, the results obtained by the various investigators for the same material vary more than do those obtained by one investigator for different materials. With the limited data at hand it seems best to neglect for the time being any variation due to differences in the nature of the conduit surface.

The plan of the writer was to obtain curves from which, having given the ratio $\frac{R}{D}$ and the velocity, the designer could pick off the excess lost head due to the bend. The method employed was to plot for each velocity all of the results which could be obtained from the published data (Figs. 6 to 10).

No use was made of the data of Williams, Hubbell and Fenkell, or of Alexander. The Detroit experimenters found that for $\frac{R}{D}$ greater than $2\frac{1}{2}$, as the ratio of $\frac{R}{D}$ increased, the loss increased instead of decreasing, as found by all of the other experimenters. In looking for the cause of the disagreement, the following facts may be noticed:

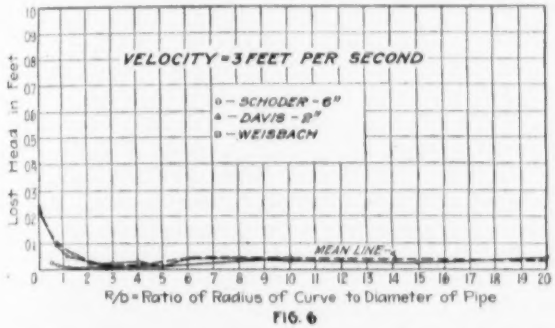
(1) The extreme smallness of the measured losses, combined with the comparatively low velocities available (the greatest about 3.5 ft. per sec. in the 30-in. pipe), would tend to magnify excess losses due to other effects than curvature.

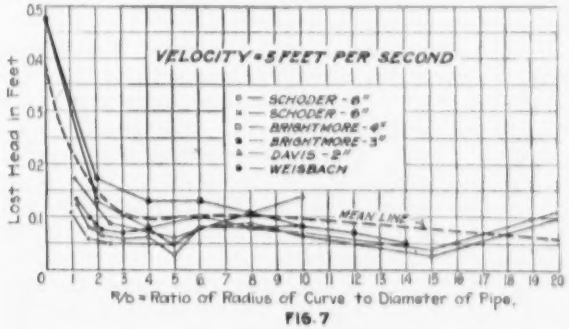
(2) The upstream piezometers were placed where they would be affected by curves in the previous section.

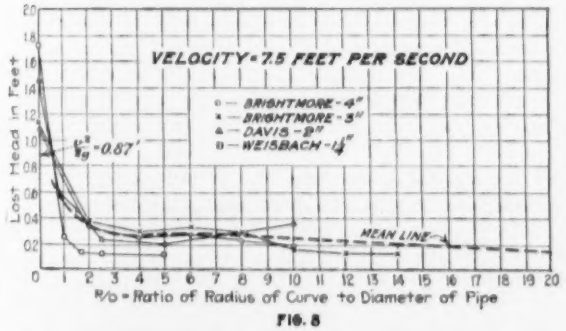
(3) The downstream piezometers were placed too near to the P. T. of the curve to measure the total loss.

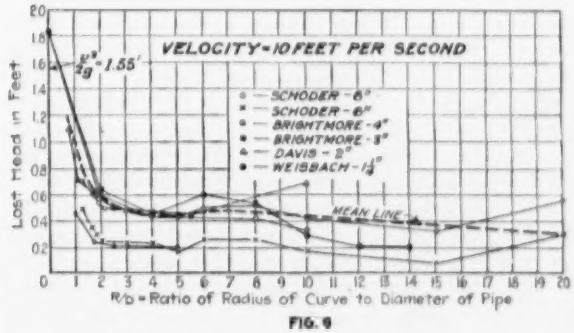
In the light of the foregoing observation, it was decided to omit these experiments from consideration, especially as they would aid in determining only the 3- and 5-ft. velocity curves (for which there are already good data), whereas our maximum is 16 ft. per sec.

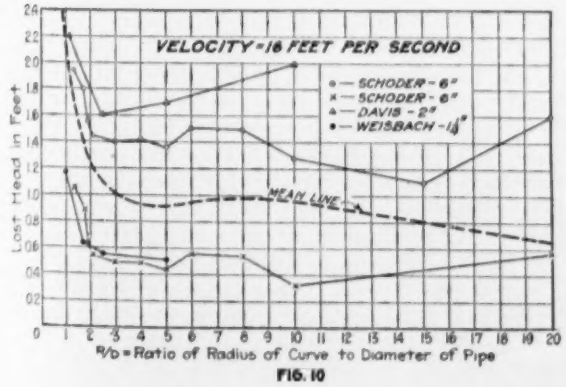
In Alexander's experiments the curves were made of wood coated with shellac, while the adjacent tangents were made of cast-iron pipe of the same diameter. As he himself points out, the connection of the cast-iron pipe

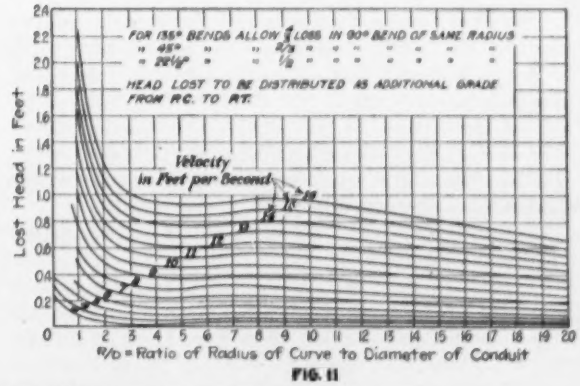

VELOCITY = 3 FEET PER SECOND
o — SCHODER - 6"
Δ — DAVIS - 2"
o — WEISBACH
MEAN LINE
Lost Head in Feet
R/D = Ratio of Radius of Curve to Diameter of Pipe
FIG. 6


VELOCITY = 5 FEET PER SECOND
o — SCHODER - 6"
× — SCHODER - 6"
□ — BRIGHTMORE - 4"
● — BRIGHTMORE - 3"
Δ — DAVIS - 2"
• — WEISBACH
MEAN LINE
Lost Head in Feet
R/D = Ratio of Radius of Curve to Diameter of Pipe.
FIG. 7


VELOCITY = 7.5 FEET PER SECOND
o — BRIGHTMORE - 4"
× — BRIGHTMORE - 3"
Δ — DAVIS - 2"
□ — WEISBACH - 1¼"
V²/2g = 0.87'
MEAN LINE
Lost Head in Feet
R/D = Ratio of Radius of Curve to Diameter of Pipe
FIG. 8


VELOCITY = 10 FEET PER SECOND
V²/2g = 1.55'
o — SCHODER - 6"
× — SCHODER - 6"
□ — BRIGHTMORE - 4"
● — BRIGHTMORE - 3"
Δ — DAVIS - 2"
● — WEISBACH - 1¼"
MEAN LINE
Lost Head in Feet
R/D = Ratio of Radius of Curve to Diameter of Pipe
FIG. 9


VELOCITY = 16 FEET PER SECOND
o — SCHODER - 6"
× — SCHODER - 6"
Δ — DAVIS - 2"
• — WEISBACH - 1¼"
MEAN LINE
Lost Head in Feet
R/D = Ratio of Radius of Curve to Diameter of Pipe
FIG. 10


FOR 135° BENDS ALLOW ¾ LOSS IN 90° BEND OF SAME RADIUS
" 45° " " ⅔ " " " " " "
" 22½° " " ½ " " " " " "
HEAD LOST TO BE DISTRIBUTED AS ADDITIONAL GRADE FROM P.C. TO P.T.
Velocity in Feet per Second
Lost Head in Feet
R/D = Ratio of Radius of Curve to Diameter of Conduit
FIG. 11

FIGS. 6 TO 11. DIAGRAMS SHOWING LOSS OF HEAD DUE TO 90° BENDS IN WATER PIPE

In Fig. 6 the average values for "n" in Kutter's formula for "C" are: Schoder's 6-in. pipe, 0.009; Davis' 2-in., 0.008; Brightmore's 4-in., 0.0158; Brightmore's 3-in., 0.007

to the wooden bend increased the disturbance at the bend considerably, and also his piezometers were not placed so as to give the total loss due to the bend. For this reason no use was made of these experiments.

Figs. 6 to 10 show the plotting of the data of the various experimenters, together with the mean line for each velocity, as estimated by the writer.

Diagram for Velocities Up to 16 Ft. per Sec.

Fig. 11 shows the assembling of the mean lines, together with the interpolated values for velocities up to 16 ft. per sec. It must be borne in mind that the curves thus drawn are for 90° bands. Referring back to Figs. 4 and 5, we see that very little distortion takes place in the second quadrant of the 180° curve. Weisbach found that adding 90° to a 90° curve of the same radius only increased the resistance about 40%. The increased resistance was no doubt due to the greater length of pipe over which the maximum velocity was shifted toward the wall, thus increasing frictional loss.

Weisbach also found that when a tangent was introduced between two curves turning in the same direction the loss of head added by the second curve was increased, for as soon as the water reaches the tangent, the distortion begins to reduce itself; and the water not only has to be redistorted in the second curve, but energy is absorbed in the readjustment in the tangent. It seems reasonable to assume that if the tangent separating the curves is not sufficiently long to allow the curve distortion to be entirely eliminated, the full loss due to both curves will not be occasioned. We have no experiments to guide us in allowing for this condition.

When a reversal of curvature takes place, the loss which would normally occur in the downstream tangent of the first curve is evidently eliminated. However, the sudden shifting of the position of maximum velocity from one side of the conduit to the other, with the accompanying increase in eddy action, would no doubt tend to counteract the apparent gain due to the elimination of the first downstream tangent. For this reason it seems fair to assume that in the case of a reverse curve the full loss for each curve should be allowed.

Although Schoder found in his experiments on 6-in. pipe that the condition of curve-distorted flow was wiped out at a distance of 76 diameters downstream from the P. T., it seems best in the case of a conduit operating at flow-line grade to distribute the lost head due to curvature as additional grade from the P. C. to the P. T. The result will be that a portion of the straight conduit below the curve will flow under a slight head (if the conduit is assumed flowing full), which is in general not a serious condition.

Suggested Rules for Computation

In the light of the foregoing considerations, the writer suggests the following rules:

(1) For bends of 90° the lost head is to be obtained from the curves shown in Fig. 11.

(2) For bends of 45° allow two-thirds the loss of a 90° bend of the same radius; for 22½° allow one half of the 90° loss and for 135° allow four-thirds of the 90° loss.

(3) For curves turning in the same or opposite directions the best condition for flow is obtained when a minimum length of tangent separates the curves.

(4) The curve compensation in the case of a conduit operating at flow-line grade is to be distributed as additional grade from the P. C. to the P. T. of the curve.

The writer realizes the fallacy of applying the results obtained by experiments on pipes of 2-, 3-, 4- and 6-in. diameter to the larger sizes of conduits, but until some tests upon the the larger sizes are available, we are compelled to use the existing data. The uncertainty in fixing the exact position of the lost-head curves for the higher velocities, as indicated in Fig. 6, emphasizes the lack of conclusive experimental data and indicates that there is still a great need for investigation upon this subject.

Massachusetts Sand-and-Oil Road Experience*

By W. R. Farrington†

The first sand-and-oil road in Massachusetts was constructed by the state highway commission on Cape Cod, in 1905, in the town of Eastham. The "California method" was first followed, but before the completion of the road the "layer method" was adopted.

Some experiments were made with mixed sand and oil for road surfaces in 1908, but the first mixed sand-and-oil surfaces of any extent were laid in Wareham and Rochester in 1909. The layer sand-and-oil roads have therefore been in use in this state for some 10 yr., and the mixed sand-and-oil surfaces for 6 yr.

The construction of the road in Eastham and of a similar road in the adjoining town of Orleans demonstrated, however, that the California method was not economical and did not give the best results. Various experiments were made and the layer method finally evolved, the roads being completed by this method.

Road Construction by Layer Method

In constructing a road by the layer method the subgrade is shaped and any sandy places hardened. Either 1½ gal. of hot oil in two applications or 2 gal. in three applications is put on. Sand is spread over the oil after each application and the road rolled with a horse roller, it being well to do the final rolling with a steam roller if one is available.

With the ¾-gal. application of oil about 1½ in. of sand is used for covering, and with the ⅔-gal. application about 1¼ in. The 1½-gal treatment should give eventually a thickness of about 3½ in., and the 2-gal. treatment about 4 in.

If it is desired to confine to one season all work on the road properly chargeable to construction, 2 gal. of oil should be used; otherwise it is advisable to use only 1½ gal. the first season and to apply another ½ gal. the following spring. Experience has demonstrated that any surface constructed of sand and oil by the layer method will be more or less out of shape for some time after the oil is applied and that weak places will develop. It is principally for this reason that it is more satisfactory and economical to delay the application of the last ½ gal. of oil until the second season. By this method it is possible to find and strengthen any weak places and to re-

*Abstract of a paper presented before the Boston Society of Civil Engineers, Jan. 26, 1916.

†Division Engineer, Massachusetts Highway Commission, Boston, Mass.

move any inequalities in the surface by scraping with a road machine before the final application of oil.

A clean, sharp and fairly coarse sand will give the best results, but a comparatively fine sand, even one containing a small proportion of clay or loam, will give good results with the proper grade of oil.

The surface of a sand-and-oil road constructed by the layer method should have a crown of not over ½ in. to the foot and should be at least 15 ft. wide; from 16 ft. to 18 ft. is a more satisfactory width unless the shoulders are hardened, as the edges of the sand and oil will be broken down rapidly if there is any considerable amount of turning out onto soft shoulders.

The cost of the surface of sand-and-oil roads constructed by the layer method has varied from 21 to 33c. per sq.yd., the average cost being 26c. per sq.yd. This cost does not include grading, culvert work, etc., but does include shaping the subgrade.

Constructing Mixed Sand-and-Oil Roads

In constructing a mixed sand-and-oil surface the subgrade is shaped and, if sandy, is hardened with the best material available, usually sandy loam or clay. The sand and oil are heated to the proper temperatures and mixed by hand or by machine. If by hand, the mixing is done on platforms with rakes and hoes, or by turning with shovels. The mixing is continued until all the grains of sand are coated with oil. For this work, from 15 to 25 gal. of oil or oil asphalt has been used per cubic yard of loose sand, but ordinarily the best results have been obtained by the use of about 16 gal. per cu.yd. of sand if loose, or about 18 gal. if compacted. To obtain satisfactory results, the sand must be dry as well as hot. If the sand in the pit when used is fairly dry, it can be mixed in a hot mixer without preliminary heating; but this is not economical, as from 5 to 6 min. is required to mix a batch thoroughly, whereas with hot sand the mixing can be done in about 2 min. The oil, before mixing with the sand, is heated in kettles or tanks to a temperature of from 250 to 375° F., depending on its nature.

The sand-and-oil mixture is immediately carted to the road and spread, usually in one course, although under some conditions spreading in two courses may be preferable. The mixture is shaped with rakes and immediately rolled. A horse roller is used for the preliminary rolling, but the surface should be rolled with a tandem steam roller in the course of a few hours. The length of time that should elapse before using the tandem roller depends on the temperature and general weather conditions, but ordinarily any material placed in the morning can be rolled in the afternoon of the same day. During the rolling with steam roller the surface is reshaped with a road machine, which removes any inequalities developed during the preliminary rolling. The results obtained on roads not shaped with a suitable scraper during rolling have shown that this work is necessary if the best results are to be obtained on mixed sand-and-oil work. It is not advisable to use a steam roller for the preliminary rolling, as it tends to force the mixture out of shape when fresh and to produce an uneven and wavy surface.

If the grains of sand are rounded, and especially if the sizes of the grains vary little, as with ordinary beach sand, a very heavy oil asphalt gives the best results, whereas with sharp sand well graded and containing a considerable proportion of grains that will not pass a screen with ⅛-in. mesh, an oil having a viscosity of from 800 to 1,700 sec. (Lawrence viscosimeter) at 100° C. gives good results.

After the sand-and-oil mixture has been thoroughly rolled, the surface is sealed by the application of hot oil having a viscosity of from 250 to 600 sec. (Lawrence viscosimeter) at 100° C. This oil is applied at the rate of ½ gal. per sq.yd. and is spread by a pressure distributor in two ¼-gal. applications, each followed by a light covering of sand. This coat not only seals the surface of the mixed sand and oil, but also adds about ½ in. to the thickness.

A mixed sand-and-oil surface should have a crown of not over ½ in. to the foot and should be not less than 18 ft. wide, since with mixed sand and oil, even more than with a surface constructed by the layer method, the edges will be rapidly broken down if there is any considerable amount of driving from the sand-and-oil surface onto the shoulders. The thickness should be from 3½ to 4 in. before the seal coat is applied.

The cost of mixed sand-and-oil surfaces, including the seal coat, has varied from 40 to 61c. per sq.yd., the average being 52c. This cost is for the surface alone and does not include grading, culvert work, etc. The average yearly cost of maintenance for those roads which have been in use at least 5 yr. is 1.6c. per sq.yd., and for those in use 3 yr. ¾c. per sq.yd.

Traffic-Bearing Capacity of the Two Types

The amount of traffic a sand-and-oil road will safely carry is as yet somewhat problematic. It is probable that there has been no instance in this state where a sand-and-oil road of either type has failed if properly constructed of suitable material. On the other hand, the layer roads have been constructed only in those sections where the travel is comparatively light, and none of the mixed surfaces have been subjected to any very large amount of heavy traffic.

Under heavy loads the layer roads have shown some evidences of weakness, but there has been no indication of failure with the mixed surfaces. That neither road will carry a large amount of horse-drawn traffic alone is evidenced by the fact that such surfaces have in several instances been badly cut up by the passage of a troop of cavalry or a large number of transport wagons during army maneuvers.

It has also been observed that a mixed sand-and-oil surface which has carried successfully quite a heavy traffic during the summer, when the proportion of motor travel was comparatively large, has been considerably cut up in the spring before the motor-traffic season commenced, although evidently the actual number of horse-drawn vehicles was much less in the spring than during the summer.

It seems probable from the experience thus far gained with sand-and-oil roads in this state that the layer road will carry only a light traffic and is a suitable type of road only where the conditions will not warrant a more expensive surface. Aside from the amount of traffic a layer road will carry, it is probably impossible to obtain by this method as satisfactory a surface as by the mixed method. However, if the travel is light, not only can a surface be constructed at a comparatively small cost but such a surface can be economically maintained.

Activated-Sludge Experiments at Milwaukee, Wis.*

By T. Chalkley Hatton†

SYNOPSIS—Varied and extended studies of the activated-sludge process of sewage treatment conducted during the past year are summarized and conclusions drawn. The previous article, which appeared in the issue of Feb. 10, 1916, outlined the experimental plant and summarized the results obtained with different kinds of air diffusers.

II. General Results and Costs

Our experiments to determine the volume of air required for oxidation and for agitation and the volume delivered from which no useful work is secured have not been conclusive, except to show that far more energy is imparted by the volume of air supplied than is necessary for oxidization or agitation; but the air performs other useful work in the process, which cannot be performed by mechanical agitators and the exact nature of which we have not yet ascertained.

Purification may be effected by means of mechanical agitators with less air than if air agitation is used; but the time required is much greater, and the sludge is broken up into much smaller particles, is less absorbent and settles less rapidly.

From our experiments along these lines we are of the opinion that the most economic agent for agitating the liquor is air applied in such volumes as may be determined in each case to procure the degree of purification desired. This naturally brings about the statement that activated sludge accomplishes four principal functions—the clarification of the liquor, removal of the putrescible organic matter, reduction of bacteria and, finally, if the process be continued for a sufficient period, oxidization of the ammoniacal compounds into nitrates. Therefore, one of the first steps in designing a plant in which this process is to be employed is to determine the degree of purification required, following which arise questions as to efficiency, volume of air required, period of application, and volume of activated sludge necessary to be kept in retention with the raw liquor.

Statement of the Milwaukee Problem

Our problem in Milwaukee embraces the clarification of the liquor, securing an effluent that is stable for five days, the reduction of the suspended matters 90%, nd 95% removal of bacteria at 20° C. With our continuous flow tank we have secured this average effluent for months by using 1.75 cu.ft. of air per gallon of sewage with 4 hr. aëration, 20% activated sludge and from 10 to 15 min. sedimentation period. Basing these results upon the operation of a 50,000,000-gal. plant, the estimated cost will be $4.38 per 1,000,000 gal., including all overhead and boiler-room charges, but excluding engine-room and plant attendance and the cost of disposing of the sludge.

There appears to be no difference in the results obtained by carrying out the process either by the fill-and-draw or the continuous-flow method, considering volume of air applied per gallon, cost of aëration and volume of activated sludge required; but measured in terms of cost of construction and operation, the continuous flow is the superior method. With a wide variation in strength of liquor and rate of flow a more uniform standard of effluent can be obtained from the fill-and-draw method, because it is susceptible of better control, which is true of all fill-and-draw processes.

In order to maintain clarification and stability and to remove at least 95% of the bacteria from the Milwaukee sewage we have found it necessary to carry on the nitrogen cycle far enough to develop from 3 to 5 parts of nitrates. This has not been at all difficult to maintain.

Effect of Low Temperature on the Process

We have just passed through a very interesting period, the description of which fits in at this point. By reason of a shutdown for two weeks of the main sewage pumping station no sewage could be obtained for running our experimental plant. Wishing to conserve the activated sludge in our tanks, we continued to aërate it quietly throughout this period, without adding any fresh sewage. The nitrates decreased from 5 parts to about ½ part, when the station was started. Immediately the temperature of the atmosphere grew very cold, snow came, followed by two days of thaw, followed by several days of temperature from 5 to 15° below zero.

During this time the temperature of the sewage ranged from 55° F. to 42° F.; the effluent was uniformly clear, with four days' stability, 90% removal of bacteria and a reduction of nitrates from 0.7 to 0.5, there being about the same amount in the raw sewage. During this time the volume of air, rate of application, and volume of liquor treated were not changed from the cycle in which the plant was being operated prior to the shutdown.

This indicates that low temperatures are not going to affect the process as much as we had anticipated. We believe, however, that the effect of such low temperatures continuing over long periods may be easily overcome by adding more air or by a higher degree of activated sludge or by both. Thus the trouble can be overcome without excess tankage.

If more air is applied for a greater period, of course the nitrates are greatly and rapidly increased. This increases the value of the sludge. Whether this increase will pay for the additional air used is a matter yet to be determined.

Results with Various Periods of Aëration

Table 1, taken from the results obtained during a line of experiments on the fill-and-draw tank, illustrates the effect of the same rate of air applied over increasing periods.

These data clearly point to the fact that well-activated sludge coagulated the colloidal matters about as com-

*Slightly condensed from a paper read before the Illinois Section of the American Water-Works Association and the Illinois State Engineers' Society, at Urbana, Ill., Jan. 27, 1916.

†Chief Engineer, Sewerage Commission, Milwaukee, Wis.

pletely in 1 hr. as in 5 hr. In 3 hr. it had removed 92% of the bacteria and made the effluent stable for more than five days.

TABLE 1. PURIFICATION OF SEWAGE COMPARED WITH PERIOD OF AERATION

Aeration, hr.	0	1	2	3	4	5
Cu.ft. of air per min.	0	160	160	160	160	160
Cu.ft. of air per gal.	0	0.67	1.32	1.98	2.64	3.31
Appearance of settled liquor	Turbid	Clear	Clear	Clear	Clear	Clear
Stability, hr.	0	2	33	120+	120+	120+
Bacteria removed, %	0	52	81+	92+	95+	98+
Free Ammonia, parts per million	22.00	17.00	15.00	11.00	7.00	5.00
Nitrate, parts per million	0.08	0.00	0.95	1.75	2.20	2.50
Nitrate, parts per million	0.08	0.04	0.70	2.80	5.60	8.20
Dissolved oxygen, parts per million	0.00	0.30	1.90	4.30	5.90	6.70

The most economical ratio between diffusing surface and tank surface has not been definitely determined. Our ratios run from 1 to 5 to 1 to 8.5. There appears to be no appreciable difference in the results obtained. We are inclined to the belief, however, that a much greater ratio would reduce the efficiency by permitting more air to escape without giving the liquor the maximum opportunity to absorb it.

While all of our experiments have been made upon tanks holding 8 to 10 ft. of liquor, our supplementary experiments indicate that more efficiency of air can be obtained in deeper tanks by reason of the longer contact period between the air and the liquor and the tendency of the air, as it escapes from the diffuser, to break up into smaller bubbles because the pressure head upon it has been increased. Local conditions might, and probably would, largely control the depth of tank.

It appears to be true that the greater pressure for which a blower is built (considering the larger units) the greater its efficiency; that is, a blower which will deliver the air at 10 lb. pressure is more efficient than one which will deliver the same volume of air at 5 lb. pressure.

Volume of Applied Air Important Factor

The purification of sewage obtained varies decidedly with the volume of air applied. Small volumes applied for 5 or 6 hr. do as well as larger volumes applied for 3 or 4 hr.; but the time of aëration required to obtain a like effluent does not vary directly with the volume of air applied per unit of time. For instance, air applied at a rate of 2 cu.ft. per min. purifies the sewage in less time than 1 cu.ft. of air per minute, but will not accomplish an equal degree of purification in one-half the time.

There is also a limit to the volume of air applied per period of application, below which it is not possible to secure any significant degree of purification. If less than 1 cu.ft. of air per gallon of sewage treated be applied for a period of 4 hr., the degree of purification of the Milwaukee sewage rapidly decreases until little or none is effected; but if the period of application is continued long enough, this rate of air will produce any degree of purification required.

TABLE 2. RELATION BETWEEN THE VOLUME OF AIR APPLIED AND PURIFICATION IN THE CONTINUOUS-FLOW TANK

Average No. of Cu. ft. of Air applied per Gal.	Gal. Treated per Day	Stability Hr.	% Bacteria Removed	Nitrogen as Free Ammonia Parts per Million	Nitrate Parts per Million	Organic Nitrogen, Parts per Million	Suspended Matter, Parts per Million
1.80	62,000	120	98	1.95	8.5	4	11
1.53	65,000	120	99	5.79	9.0	8	9
1.12	65,000	73	91	10.10	2.3	14	42

Table 2 shows that air applied for 5 hr. at the rate of 1.53 cu.ft. per gal. purified the sewage very well; but when applied at a rate of about 1 ft., the stability fell off very materially.

In view of the fact that the air is the most important item of cost in the operation of the activated-sludge process we tried out many experiments with the purpose of determining the effect of decreasing the period of aëration and rate of application. It was evident that by reducing the volume of air the efficiency of the process was decreased. When the period of aëration dropped to 2½ hr., although the air feed was increased proportionately, nitrates were formed in such small quantities that the settled liquors putrefied in about four days.

Land Area and Construction Costs per 1,000,000 Gal.

Our experiments so far indicate that, with rectangular tanks 15 ft. deep, 15,000,000 gal. of sewage can be treated per acre of ground covered, including influent and effluent conduits, sedimentation and sludge tanks, and that the cost of such tanks, including influent and effluent conduits, pipe foundations and all piping, will be approximately $18,000 per 1,000,000 gal. This cost is based upon our local conditions, where the tanks have to be built out into the lake and supported upon piles.

The sedimentation period required to reduce the suspended solids to 10 or 12 parts per million is from 10 to 25 min. The latter seems to be a maximum with low temperatures.

We speak of maintaining a certain percentage of activated sludge with the sewage during aëration. In order to establish an easily determined unit we have fixed on that volume settling during ½ hr. It is true that this is an arbitrary determination, but it is logical nevertheless. From a great many tests it has been found that 78% of well-activated sludge will settle out of the mixture in ½ hr. and that during the next ½ hr. the addition is but 4%. It is desirable, in operating a plant, to determine frequently the volume of this sludge in contact with the liquor. One hour is often too late to get the most benefit from any change demanded. This sludge, so settled out, has about 98% moisture content, and it is desirable to return this sludge to the raw sewage with as little water content as practicable, because the more water the more tank area required.

To get this result, it is necessary, not only to let the sludge settle for at least ½ hr., but also to put it under a pressure from a head of water over it. In our new tanks we let the sludge from the sedimentation tank settle to the bottom of a 4-ft. chamber built under the tank and 35 ft. deep, whence it is pumped out after being compacted by a head due to 34 ft. of the liquor over it. Then it is further aërated in reservation sludge tanks, again settled, and pumped from the bottom of the second sludge-settling tank to the raw sewage.

From our experiments we find that under a 26-ft. head of liquor the sludge will be dewatered in ½ hr. from 98% to 94% and lose 40% of its volume. If a 94% rich activated sludge can be mixed with the raw sewage as it enters the aërating tanks, the size of these tanks can be materially reduced. By extra aërating the sludge to be returned to the raw sewage it is believed that the volume of air required to treat raw sewage will be diminished. Thus the cost will be decreased, because it will require only one-fifth of the volume of air to give this sludge the extra aëration (providing 20% of activated sludge is being maintained in the sewage

tanks) that is required to give the whole body of sewage treated the same air treatment. It has been demonstrated beyond doubt that the richer the activated sludge in nitrates the quicker the purification of the sewage, and the less air required.

The sludge produced is quite brown in color, appears like pieces of finely divided sponge and settles out of the quiet liquor very rapidly—65% will settle in 10 min. It is readily drained on the ordinary sludge-drying beds, requiring about one-half as much time as does well-digested Imhoff sludge, but it acts differently. During the first hour the liquid drains through the bottom. The sludge, gradually settling upon the surface, seems to close the interstices of the bed; the liquid rises to the top of the sludge, from which it can be titrated without disturbing the settled sludge. With two days of dry, warm weather its moisture content will be reduced on drying beds from 98% to 82%, and in two weeks the moisture will be reduced to 65%.

The sludge seems to absorb the colloidal matter very rapidly. Highly colored liquor introduced into it will be decolored in a few minutes. It has no apparent odor. When well activated, the sludge produced by the Milwaukee sewage contains from 14,000,000 to 18,000,000 bacteria per c.c., from 5 to 6% of fats and 4.4 to 9% of total nitrogen (NH_3), based upon 10% moisture. At the present market the value of this sludge, when degreased and reduced to fertilizer—that is, dried to 10% moisture and ground—ranges from $10 to $20 per short ton.

The Milwaukee sewage produces on an average about 3,000 gal. of sludge per 1,000,000 gal. at 98% moisture. On the basis of 10% moisture it produces about ½ ton per 1,000,000 gal.

The cost of dewatering, degreasing and drying the sludge has not yet been definitely determined, but from a careful study of this question it is believed that this cost will not exceed $6 per dry ton. Apparatus for performing this portion of the work has already been arranged for and will be installed in our new 2,000,000-gal. plant during February, 1916.

We feel sufficient confidence in the process to have recommended it for adoption by the City of Milwaukee and have suggested a 100,000,000-gal. plant, the designs of which are already in course of preparation.

It has been frequently stated in public print that the process is so delicate in its operation that only by the exercise of the most careful supervision can satisfactory results be secured. We believe this to be an error, as we have found no conditions arising which would lead us to such a conclusion; and if one realizes the simplicity of the process, he will certainly agree with us.

Assuming the plant is properly designed and built, there are only two main factors to be considered in successfully operating it, and these can be determined by a careful and skilled workman. Proper volume of air and activated sludge are these two factors. The character of the effluent is very well shown by two things—turbidity and suspended matter. Both can be determined in a test tube by observation. Volume of activated sludge can be determined in ½ hr. by the same means. The quality of the sludge can be judged by its color, after the observer has had some experience.

If the character of the effluent, as measured by turbidity and suspended solids, is not satisfactory, the first step is to find out the percentage and color of the sludge. If this has been reduced, two valves must be opened a little wider—the air valve to the sludge-aërating tank and the sludge valve controlling the sludge feed to the raw sewage. If this fails to get the results, the air valve feeding the aërating tanks is to be opened wider. Under ordinary conditions the last step would be the first, because it will immediately rectify the trouble temporarily until the sludge determinations are made.

Stresses in Rivets Used in Direct Tension

By Jacob M. Friedland*

In the discussion of the use of rivets in direct tension that was recently called out by the letter of Ernest McCullough in *Engineering News* of June 10, 1915, it appeared that current good practice is against such use. Edward Godfrey, however, seems to be of the opinion that for this antagonism there is no good theoretical basis, since according to him, "a little analysis will show that pulling on the head of a rivet already in stress due to shrinkage does not increase the stress on the rivet but relieves the pressure on the plates, unless the added tension exceeds that already in the rivet."

If the above statement were true, there would indeed seem to be no reason against applying dead-load or moderate live-loads up to the temperature stress in the

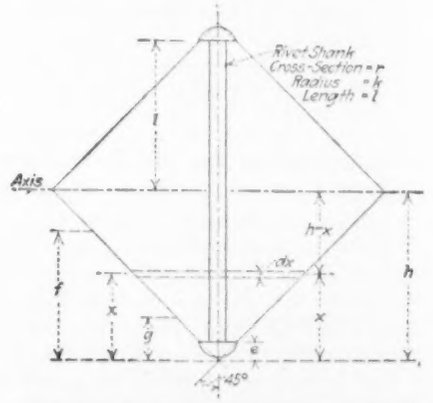


DIAGRAM SHOWING RIVET IN TENSION

rivet, for the mere fact that the rivet has not ruptured after driving shows that it is capable of sustaining at least such a load.

But while a *little* analysis may show what Mr. Godfrey says it shows, the study given below produces quite different results.

The accompanying drawing shows a rivet between whose heads is metal (plates, angles) having a total thickness $2\,l$. This metal fits snugly around the rivet shank and is under initial compression due to the shrinkage of the rivet on cooling. The "axis" is a line drawn midway between the rivet heads, and loads, stresses, etc., above the axis are the same as below it.

For the purpose of the following analysis it has been considered sufficient to assume that the volume of stressed metal consists of two truncated cones base to base (on the axis) with an angle of 90° at the apex, the rivet hole

*Borough Hall, Bronx, New York City.

being deducted from the area, and that within this volume the compression stresses are uniformly distributed over each horizontal layer, decreasing in intensity as the layer increases. The minimum area, under the rivet head, is equal to the under side of the rivet head.

A load p is attached to the layer located x inches above the apex of the lower cone. Part of p, say w, will compress the metal $x - e$ below the layer, and reacting against the rivet head, will stretch the rivet shank; while the remainder $p - w$ will stretch the metal $h - x$ above the layer. The elastic deformation is such that the stretch in the rivet plus the compression in the metal below p must equal the stretch in the metal above p. If s is the area of any horizontal layer of metal, dx its thickness, E the coefficient of elasticity of steel, r the cross-section of the upset rivet shank, the above equality is given by the formula

$$(p-w)\int_x^h \frac{dx}{Es} = w\int_e^x \frac{dx}{Es} + \frac{wl}{Er}$$

from which we get the fraction of the load p that goes to increase the initial rivet stress

$$\frac{w}{p} = \frac{\int_x^h \frac{dx}{s}}{\int_e^h \frac{dx}{s} + \frac{l}{r}} \qquad (1)$$

that is, the load transmitted to the rivet is to the load suspended as the extensibility or "give" in the metal from the axis down to the load is to the extensibility or "give" in the whole system, rivet shank included.

If a depth of metal between $x = g$ and $x = f$, having a thickness $f-g$, is continuously loaded with a total load P, the intensity per inch depth is $\frac{P}{f-g}$, and p in formula (1) becomes $\frac{P}{f-g}\,dx$. The fraction of the total load P transmitted to the rivet is then given by

$$\frac{\int_g^f w\,dx}{P} = \frac{1}{f-g}\int_g^f \frac{\int_x^h \frac{dx}{s}}{\int_e^h \frac{dx}{s} + \frac{l}{r}}\,dx \qquad (2)$$

If k is the radius of the upset rivet shank, $s = \pi(x^2 - k^2)$, and (2) becomes

$$\frac{w}{p} = \frac{\int_x^h \frac{dx}{\pi(x^2-k^2)}}{\int_e^h \frac{dx}{\pi(x^2-k^2)} + \frac{l}{r}}$$

$$= \frac{\frac{1}{2\pi k}\left(\log\frac{h-k}{h+k} - \log\frac{x-k}{x+k}\right)}{\frac{1}{2\pi k}\left(\log\frac{h-k}{h+k} - \log\frac{e-k}{e+k}\right) + \frac{l}{r}} = \frac{N}{D} \qquad (3)$$

which when integrated gives the formidable-looking but perfectly docile expression

$$\frac{\int_g^f w\,dx}{P} = \frac{1}{f-g}\,\frac{\frac{1}{2\pi k}\{(f-g)\log\frac{h-k}{h+k} - (f-k)\log\frac{(f-k)+(f+k)\log(f+k) + (g-k)\log(g-k) - (g+k)\log(g+k)}{D}}{D} \qquad (4)$$

The logs are Naperian logs, that is, common logs multiplied by 2.3. The application of the formula gives the following percentages of the suspended load that tend to increase the initial tensile stresses in the rivet:

Two ⅜-in. angles back to back, held by a ⅞-in. rivet, 13%.

Two ½-in. angles back to back, held by a ⅞-in. rivet, 11.3%.

Two ⅝-in. angles back to back, held by a ⅞-in. rivet, 9.9%.

Two ⅝-in. angles with two ½-in. plates between, the load suspended from the lower angle, 10.08%.

Two ⅝-in. angles with two ½-in. plates outside the angles acting as fillers under the rivet heads, 2.59%.

Two ⅝-in. angles with 4¾ in. of plate between, giving a total thickness of 6 in., 6.33%.

Two ½-in. angles with one ½-in. plate between (beam-connection angles on each side of a ½-in. web), 12.1%.

The use of ¾-in. rivets gives slightly smaller percentages.

The numerator of formula (1) shows that for a given thickness of metal the farther the metal carrying the load is from the rivet head the smaller is the percentage of the transmitted stress. Formulas (3) and (4) and the computed results show that the thicker the metal between the rivet heads, and the thinner the rivet, the greater is the extensibility of the whole system, and therefore the smaller is the percentage of the load transmitted to the rivet. But until more is known about the way in which an increase in the thickness of the metal affects the initial rivet stress, these deductions warrant neither the arbitrary thickening of the metal nor the insertion of fillers for the purpose of keeping the load-carrying metal away from the rivet heads. In fact computations based upon the assumption that the *initial* rivet stress is distributed in the plates in the same way as the *direct-load* stress seem to indicate that up to 6 in., at least, the initial stress increases faster with an increase in thickness of gripped plate than the transmitted direct load decreases.

If a load of 8,000 lb. per sq.in. of rivet metal, or 4,800 lb. per ⅞-in. rivet, is applied in direct tension, 13% of this adds only 1,040 lb. per sq.in., or 625 lb. per rivet, to the initial rivet stress. For short rivets, which are easier to drive properly than long rivets, this additional load will not cause rupture, even if we consider the necessarily eccentric application of the load through flexible angles. Where the direct pull is very great, for example, the pull on the rivet heads of connecting angles, produced by end moments in beams framed into girders, which according to computation at least, may exceed 16,000 lb. per ¾-in. rivet, an addition of 12%, or 4,340 lb. per sq.in., may rupture even a properly driven rivet.

The above analysis shows, on the one hand, why many direct-tension details do not fail; and on the other hand, where their weakness lies, and the limitations under which it may be safe to design such details. If rules are justified by theoretical analysis without substantiating tests, the following seem to be warranted:

1. For rivets easy to drive properly, a load of 6,000 lb. to 8,000 lb. per sq.in. may be allowed if the rivet acts in tension only and is not subject to shear, in fact (not on assumption).

2. The precautions prescribed by Mr. Godfrey should be observed.

3. The inherent weakness of rivets is that they often have an initial stress above what would be permitted in safe steel design. As a direct tensile load always adds to the initial stress, one is forced to the conclusion that details involving direct tension on rivets should be avoided.

Flood Control in Los Angeles County in California--II

SYNOPSIS—The serious flood damages in Los Angeles County, Calif., due to the steep mountains on which heavy rainfall occurs in winter discharging sudden floods upon the plains, were explained in the preceding article. The present article summarizes the methods of preventing flood damage recommended by the Board of Engineers appointed to study the problem.

In southern California the débris cones have no little effect on the problem of flood prevention. Wherever the torrents from these steep mountains debouch upon the plains, they have built up in the course of past ages a fan-shaped deposit of sand, gravel and boulders, often hundreds of feet in depth. While débris cones are more or less familiar to engineers as a feature of topography, they assume great importance in this southern California region, where the geological structure of the country is so recent that the process of mountain erosion and valley deposits can be watched at the present time.

The amount of solid matter carried down by these mountain streams when in flood is almost incredibly great. The heaviest material—boulders, cobblestones, etc.—is deposited in the lower reaches of the torrent, where the velocity lessens, or immediately at the mouth of the cañon. Gravel and coarse sand are deposited all along the débris cone, wherever the stream velocity slackens. Finer material is carried in suspension for miles down the stream and even to the ocean 30 mi. away.

It is estimated that 365,000 cu.yd. of material was deposited in Los Angeles harbor by the flood of 1911. The deposit in the dredged areas of Los Angeles harbor during the flood of 1914 is estimated at 2,600,000 cu.yd.

FIG. 1. FLOOD IN LOS ANGELES RIVER BELOW CERRITOS BRIDGE. PACIFIC ELECTRIC RY., JAN. 18, 1916

The view shows the break in the levee erected by the city to confine the river to its own channel. The waters flowing through the bridge in this levee are cutting across the Dominguez Ranch and into Dominguez Creek and rapidly eroding a new channel

and in the adjacent Long Beach harbor at 700,000 cu.yd. Including material deposited in areas that have not yet been dredged, it is estimated that fully 4,000,000 cu.yd. was deposited in these harbors as a result of the 1914 floods.

Of this fine material carried into the ocean, however, only a small part comes from the mountain slopes. The rivers left their old channels and spread over the rich plains near the ocean, and the report says: "These flood waters rushing over the rich arable land between Wilmington and Long Beach, which was practically all under cultivation, eroded therefrom immense quantities of valuable soil."

Regulating Streams Without Channels

In order to understand the difficult problem of flood control in this section it should be understood that these huge floods are discharged onto plains which have in many cases no well-defined channel for their discharge. The

FIG. 2. DAMAGE DONE BY LOS ANGELES RIVER FLOOD AT LONG BEACH, CALIF., JAN. 18, 1916

mountain torrent brings its huge burden of débris down to the mouth of the cañon, chokes the channel below with it and then spreads out on each side. What is true of this immediate point is true lower down. The stream bed is being continually built up above the surrounding country as the flood slackens and the stream velocity grows less. The tendency to channel choking is aggravated by the rapid growth of willows and other vegetation in the bed of the stream. In this climate such vegetation, fed by the underflow of the stream, very quickly chokes and restricts the channel and increases the deposit of débris. Thus nature left to itself is continually blocking up the old channels of the rivers and opening new ones.

The plains upon which these mountain torrents discharge contain some of the most valuable agricultural lands in the United States. The citrus groves, fruit farms and truck farms on these plains, worth thousands of dollars an acre, may be a long distance from any of the old stream channels made by the floods of former years and yet be liable to be overwhelmed when the next flood comes.

Moreover, the flood in this section does not merely inundate the land with water. This, with the damage or destruction of buildings and improvements, would be

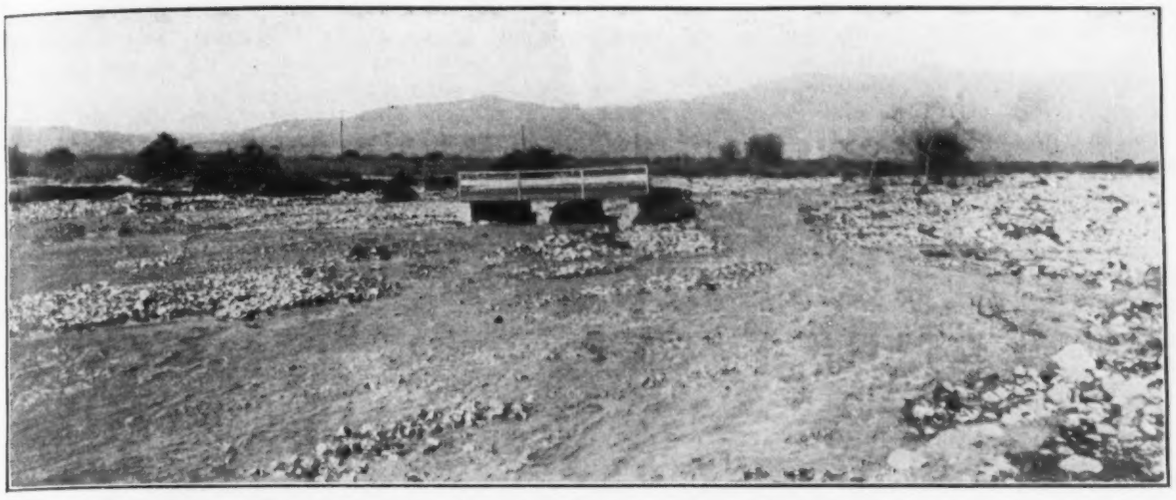


FIG. 3. SAN ANTONIO CREEK SPREADING OVER ITS DEBRIS CONE

bad enough; but what happens when one of these southern California floods starts in a new direction is, first, excavation of a new channel, tearing out and carrying away the fertile top soil, and, later, as the flood subsides, filling in this channel with a deep deposit of barren sand and gravel.

Besides the valuable agricultural lands that are threatened by these floods, the entire district around Los Angeles contains essentially suburban territory for a long distance. The damage done to buildings, bridges, roads and other city and village property in the great flood of two years ago was enormous in amount. As can be seen from the situation just described, it is not a matter merely of risking the loss of buildings and land near the old stream channels. The uncertain path of the floods brings the homes of a very large population within the danger zone.

Possible Methods of Flood Prevention

A great deal has been printed within the last few years on the relation of forests to floods. There still remains a widespread popular belief that, if a region is covered with a heavy forest growth, floods from it will not occur. The fallacy of this idea is well illustrated by the situation in Los Angeles County. The mountains from which these destructive floods come are for the most part clothed with a heavy growth of shrubbery native to the locality. The long dry season when practically no rainfall occurs, from the middle of April to the middle of October, makes impossible any larger forest growth on these mountains; but even if it were possible to produce it, there is no reason to believe that it would more effectively protect these steep mountain slopes from wash than does the shrubbery now growing there; and it might not give as much protection.

FIG. 4 CHANNEL OF ARROYO SECO IN LOS ANGELES PROTECTED BY MASONRY WALL

It is true that fire has swept over some small portions of the mountains and burned off the shrubbery. From these areas the wash of solid matter is much heavier in time of severe rains, and the commission recommends that a moderate amount be spent in planting brush growth on these now barren areas. It is clearly understood, however, that no possible forest cover on these steep mountain slopes will prevent some soil wash from them in time of heavy rain.

The storage of flood waters in great reservoirs has been thoroughly discussed in engineering literature. The two great obstacles to its adoption in Los Angeles County are the lack of suitable reservoir sites and the fact that the great amount of solid matter carried by the stream would very quickly fill a storage reservoir full, if it were built. The commission nevertheless has examined two or three possible sites for storage reservoirs and considers their use possible in connection with other measures hereafter to be described.

The Plans Recommended

The foregoing brief review will give the reader some idea of the unusual difficulties, never presented elsewhere in the United States in connection with the question of flood control. If the region affected were in the same condition as 25 years ago, the problem might well be given up as unsolvable from the financial point of view. The great increase in population, wealth and land values in the territory affected, however, and the serious threat to the safety of life and property which the floods constitute make an engineering solution imperative.

It will be evident from the review herewith that the difficulty in the flood-control problem in Los Angeles County arises not so much from the great volume of

water to be handled as from the enormous amount of solid matter, boulders, gravel, sand and silt brought down by the floods. To retain this solid matter, or a great part of it, in the mountains and prevent its discharge upon the plain is therefore one of the first essentials in solving the flood-control problem. The commission hopes to effect this by going direct to the flood sources and there building rough check dams on the mountain torrents. By these check dams it is hoped so to reduce the velocity of the torrents as to prevent most of the boulders and gravel, at least, from being carried down with the water. In a following article Mr. Frank H. Olmsted, of the commission, describes the check dams which have already been built as an experiment for the control of mountain torrents and which are to be largely extended.

FIG. 5. A CONCRETE BRIDGE ON THE NEW STATE HIGHWAY AT CROSSING OF SAN ANTONIO CREEK

Storing Flood Waters Underground

Reference was made above to the débris cones, enormous deposits of gravel and sand that have been built up wherever a stream from the mountains issues upon the plain. In the interstices of these vast gravel beds is stored the water from which the supply is drawn to irrigate the great bulk of the fertile lands lying between the mountains and the sea. Were the rainfall uniform throughout the year and the flow of the streams of the mountains fairly constant, there is little doubt that the entire runoff from the mountain section would be swallowed up by the river bed and spread out as an underflow over all this vast porous plain, and little or none would ever reach the ocean as a visible flow in the channels of the rivers.

The material in the débris cones has been sorted in the process by which they have been built up. Near the mountains one finds coarse gravel, cobbles and boulders extending to great depths. Farther away the material is fine gravels and sand. Beyond the present visible débris cones, toward the ocean, the deposits change to the finer sands and silt.

It will be evident that water flows underground more readily in the coarse deposits near the mountains than in the finer deposits found on the plains. These fine deposits, in fact, act like a dam to obstruct the flow of the underground waters toward the sea and thus conserve the supply for the use of irrigators, who pump it from wells. Further, the greater the amount of water that can be poured into these débris cones at their highest points, next the mountains, the greater will be the available underground supply for the wells of the ranches farther down the plain.

The flood commission favors, therefore, measures to divert as much as possible of the flood flow into these underground reservoirs. All the water that can be thus disposed of will be so much less to take care of in the lower courses of the stream and will be so much added to the available store on which the irrigators may draw.

Precedent exists, fortunately, for this diversion underground of flood waters. In San Bernardino County a large amount of work has been done in the past few years in spreading the river flow upon the débris cones. Experience there has shown that flood waters can be diverted underground at a cost of approximately 14c. per acre-foot, including both operating and interest charges. This is less than 5% of the value of the water for irrigation purposes. To secure the best results, however, the channels in which the water is spread on the débris cones should be kept free from the muddy water discharged in time of flood, as this rapidly clogs the infiltration channels to the detriment of the flow.

FIG. 6. GRAVEL PIT 30 FT. DEEP ON PACIFIC ELECTRIC RY. FILLED FULL BY SAN ANTONIO CREEK

Note that a channel has been cut across the main-line track

FIG. 7. SANTA FE RY. BRIDGE ACROSS SAN ANTONIO CREEK NEAR LOS ANGELES

Part of spans blocked by débris and dangerous scour around others

After all has been done that can be done in protecting the mountain slopes from erosion, in checking the rate of flow of the mountain torrents by check dams, brush dams, etc., to delay the progress of the floods and especially to prevent the carrying down of boulders and gravel to clog the channels across the plains below, and after as much has been done as can be done to divert the waters into the underground reservoirs formed by the débris cones, there will still remain a great volume of flood water to be discharged down the old stream channels.

To enable these channels to carry this flow, a large amount of work will be required in clearing the channels from débris and willow growth and in protecting their banks, by training walls of various sorts, from erosion and overtopping. A great many different types of structure are recommended, according to the local conditions.

Estimate of Cost

The total estimated cost of the entire works recommended by the board for flood prevention is $16,509,000. Of this estimate a little less than $13,000,000 is for structures, and about $3,700,000 is for rights-of-way and land damages. In the estimate of cost of physical structures an addition of 30% has been made to the field cost, to cover such overhead charges as engineering, legal and general expenses, workmen's compensation insurance (a heavy item under California law) and provision for minor waterways not specifically mentioned.

The total estimated cost of the impeding dams, contour furrows, etc., to be built to control the mountain torrents is about $1,700,000. The works for spreading the water on the débris cones are estimated to cost about $1,500,000. For clearing and leveeing the channels of the streams through the San Fernando and San Gabriel district the estimated cost is over $7,000,000, including the rights-of-way; and for the channels across the plain leading to the ocean, about $5,500,000. It is estimated that at least five years' time will be required for the construction of the works recommended.

The Floods of 1916

Since this article and the one preceding it were prepared for publication, Los Angeles County has suffered two severe floods. While the damage was not nearly as great as in the flood of 1914, it was of large amount as may be judged from the accompanying views.

The first flood reached its maximum stage on Jan. 17, 1916, and carried away more than a score of bridges in Los Angeles County, many of them of considerable size. The approaches to many other bridges were washed out so as to render them impassable, and much damage was done to railway roadbeds and highways; the network of interurban electric railways was tied up, and trains were discontinued on most of the steam railways. Several lives were lost in the floods, most of them in the mountain cañons. In the lower lands many families were rescued from their homes in boats.

The damage done by this flood was sufficiently repaired so that train service was just resumed when there came a second severe storm on Jan. 27, the same which wrought such serious damage in San Diego County; and the railway lines were again put out of business.

The rainfall in the Los Angeles River and Hondo drainage basins was much less than in the great storm of February, 1914, and the flood damages on these streams were small compared with the destruction in that year. In the flood of 1914 the Arroyo Seco, a tributary of the Los Angeles River, destroyed a number of houses and half a city park. Since that storm the city has built a heavy wall along this stream and the damage done by it this year was trifling.

In the southern part of Los Angeles County, however, the flood situation was worse than in 1914. The high mountains in this section were covered with snow from an earlier storm. The heavy rainfall melted this snow and the San Gabriel River was higher than in 1914. Similar conditions existed in San Antonio Creek and the Santa Ana River. On the latter stream three steel bridges and one wooden bridge were destroyed.

The accompanying views show something of the destruction wrought by the recent flood and particularly the extent to which the floods spread boulders, gravel and débris over a wide area. Some of the photographs show the channels across the débris cone. The débris cone of San Antonio Creek, for example, extends from Pomona to Ontario, a distance of about 6 mi. The various channels which the stream has formed across the cone are known as "washes." A correspondent informs us that even after the flood had subsided to comparatively small proportions one could distinctly hear the boulders rolling down these channels from a distance of 300 ft.

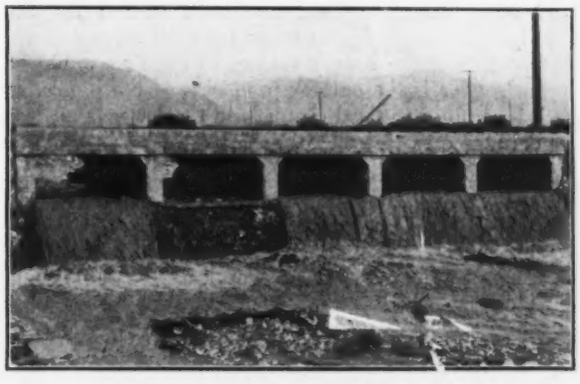


FIG. 8. FLOODS PASSING RAILWAY BRIDGE
Showing effect of paving stream bed between piers and erosion on lower side

A good illustration of the flood damage where the streams enter the ocean is furnished by the Santa Ana River, which empties into an arm of Newport Bay. A year ago the channel of the river was dredged from Santa Ana to its mouth and the banks were diked with the material excavated. During the flood the river broke over these dikes, flowed through the streets of Anaheim, flooded a great area of flat land, overtopped the line of sand dunes lying between it and the ocean, and washed out a channel over 1,000 ft. wide through the dunes, carrying with it the track and poles of the Pacific Electric Ry.

In view of the great damage done by this year's floods there can be little doubt that the plans of the Los Angeles Flood Commission's engineers will receive a public attention that might not otherwise have been given them and prompt action may be looked for to carry these plans into effect. The Board of Supervisors of the county in September last approved a general policy of flood control and an initial bond issue of $6,000,000 to begin the work. A flood-control district, with authority to make bond issues, was created by the last legislature and actual work on construction is likely to go forward soon.

Control of Mountain Torrents by Check Dams*

By Frank H. Olmsted†

The flood damage already sustained in Los Angeles County is small compared with what the coming years promise, unless a wise policy of control is energetically pursued from this time on.

The mountain area of Los Angeles County, which discharges its water onto the plains lying between the mountains and the sea, has an area of 615 sq.mi. The average elevation of this mountain district is 3,680 ft., and the average annual precipitation is between 29 and 30 in. The rainfall over this mountain area during the four days' flood period of February, 1914, averaged 14 in.

It is well known that no favorable sites exist for storing flood flow in large reservoirs in Los Angeles County. There are two available sites for small reservoirs, one holding 2,600 acre-ft., the other 4,900 acre-ft. When the cost per acre-foot of water stored exceeds $10, the proposition is not commercially attractive. The cost of water storage in small reservoir sites available in the San Gabriel Mountains averages considerably more than this.

If relief from the flood conditions in Los Angeles County had to come from surface reservoir storage alone, that portion of the county subject to overflow would be doomed. Nor is the outlook promising if the protective work is confined to flood channels in the lower lands, for the detritus carried by the streams creates in the lower rivers conditions that no construction whatever will permanently retain.

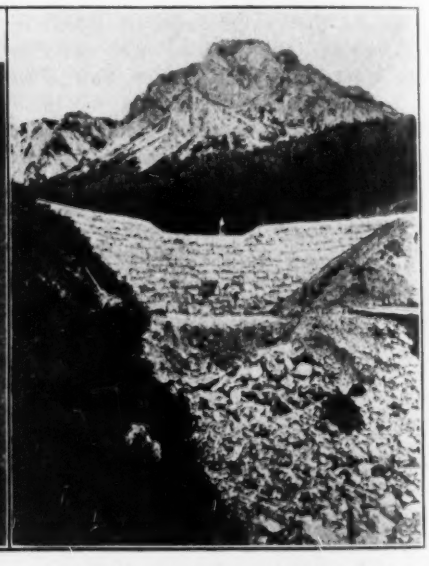
The spreading of the flood flows on the gravel cones below the cañon mouth, while important to conserve the water-supply, does not promise any great relief from the maximum flood flows. If, however, we can attack these great floods at their sources in the high mountains and utilize to the greatest extent practicable the benefits of surface storage, flood spreading, channel rectification and control, we will be able permanently to relieve the people of Los Angeles County from the menace of future floods.

The writer was authorized by the County Board of Supervisors to conduct experimental work in Haines Cañon on the effect of check dams in restricting the flow of the stream and checking erosion. Haines Cañon is a tributary of the Tujunga, the drainage area of which includes 3.9 sq.mi. of mountainside that has been entirely denuded of brush and timber from a forest fire in September, 1913. The flood discharge in February, 1914, was 712 cu.ft. per sec. per sq.mi., a higher rate than that of any other stream in the county. Under the writer's supervision there have been constructed in Haines Cañon 384 small checks for retarding the velocity of stream flow. Some of these are structures of size, costing in one case $500, but in many cases costing not over $5. The total outlay was $4,650 for construction of the dams, or an average of $12.11 each, with $1,350 additional for measurements, maintenance, etc.

In Western Empire Cañon, a small tributary of Haines Cañon, with a drainage area of 22 acres, four small check dams were built before the heavy rains of 1914-15. On Jan. 28 to 30, 1915, the rainfall totaled 9.85 in. at a rain-gaging station lower down on the stream and out of the mountains. The precipitation at times reached a rate of 1 in. per hr. It is probable that in the area draining to Western Empire Cañon the precipitation was not less than 12 or 14 in. for the full storm. The four check dams referred to, however, so retarded the flow from this cañon that no flow whatever reached the main drainage line of Haines Cañon. Further, the absorption of the flow by the porous material underlying the bed of the stream has been such that this bed is now rapidly growing up with willow and brush growth where previously there was no growth whatever. This Western Empire Cañon has a grade of 23%. The writer estimates that the construction of the four 6½-ft. dams has obstructed the progress of the water down the valley enough to alter substantially the water flow to a grade of 5.2%.

STONE CHECK DAMS AND TRAINING WALLS ON THE LUNGRO

LOG DAMS AND TRAINING WALLS IN SOUTHERN AUSTRIA

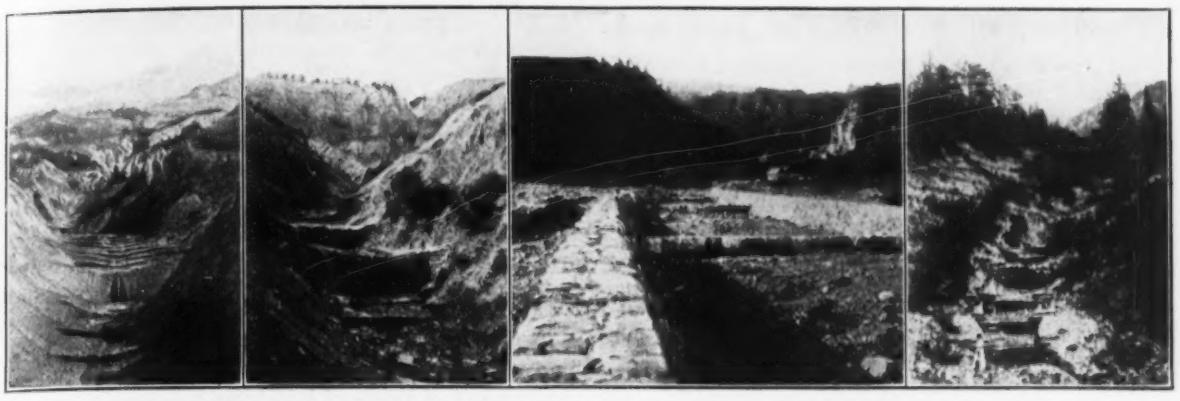


DAM BUILT OF DRY RUBBLE NEAR REICHENAU, AUSTRIA

*Extracts from a report prepared by Mr. Olmsted, as a member of the Los Angeles Flood Commission, on flood control in the mountain district of Los Angeles County.

†Consulting Engineer, Hollingsworth Building, Los Angeles, Calif.

The Federal Forestry Department has furnished the writer with information concerning work of this character that has been done in Europe and gives assurance that the work planned for Los Angeles County is along safe lines. The Austrian Government has 843 streams with which it is contending and upon which it has expended millions of dollars. The greater part of these appropriations has been expended on the very headwaters of the streams in the high mountains.



VARIOUS EXAMPLES OF CHECK DAMS ON EUROPEAN MOUNTAIN TORRENTS

Japan has expended $82,500,000 on flood control in checking the velocity of 20 streams in high mountains and 45 other streams to be controlled later.

The Landquart and Nolla, Swiss streams having watersheds of 250 sq.mi. and 72 sq.mi. respectively, in mountains about as high as our San Gabriel, furnish a historic parallel to our storm-protection problem here. Efforts have been made since 1705 to prevent flood damage in the Landquart in Switzerland, and the story of two centuries of almost wasted effort by small communities to combat the flood successfully is pathetic. Their effective work commenced in 1870, when the diking of the lower river was supplemented by the damming of the Landquart, the Nolla and the débris-carrying torrents of the high mountains. The Nolla has now over 20 main dams, of dry masonry, and 46 smaller dams.

The City of Zurich, Switzerland, owns a mountain forest called the Sihwold, and in this, as in other Swiss forests, absolute control of the streams is required before expenditure for forest improvements. Stream control in the Sihwold may be classified under three heads: First, the protection of the channels of small brooks by log dams and slab facings; second, log barrages along the upper courses of medium streams and the protection of the banks by log cribs (these barrages, aside from preventing the cutting action of the stream, form pools in which the speed of the water is checked); third, a series of masonry dams reinforced by concrete retaining walls.

The advantage of extracting 15 or 20% of a flood crest before it reaches the districts where damages occur is evident, but in practically applying this method in such streams as the San Gabriel it will be seen at once how difficult and dangerous this is. To be effective as a flood-protection factor, it must deal with the maximum that comes at the cañon mouth, and the diversions must be made when the velocities are perhaps over 15 ft. per sec. The adjacent lands over which flooding occurs are lower than the stream bed itself, and on account of this there is danger if control of the situation is lost. In addition to this the flood peaks are charged with maximum quantities of silt and débris, and the spreading areas under these conditions soon become clogged up and lose their absorptive power to a large degree. Under favorable conditions an acre of area on the boulder grounds will absorb 2 cu.ft. of water per second continuously. After silting, however, it will not absorb over 1 cu.ft.

As a conservation measure primarily and as an adjunct to flood protection, the following streams are recommended by the writer for treatment by this system:

Name of Stream	Quantity of Water To Be Absorbed, Cu.Ft. per Sec.	Estimated Cost of— Land	Works
San Gabriel	4,215	$320,000	$487,000
Tujunga	4,000	.....	500,000
Tacoima	3,750	312,500	257,686
San Bemis	95	1,575	11,310
San Antonio	2,000	75,000	50,000

It is the intention to provide in the cañons of the Verdugo watershed channels of approximately rectangular section. The sides, however, will be composed of cylinders of loose rock wrapped in heavy wire net, embedded a foot below the bottom of the channel and of sufficient diameter to give a waterway that will take care of a flow 30 to 50% in excess of the maximum observed. In the smaller streams a limiting velocity of 14 ft. per sec. was used. In the main intercepting channel this was reduced to 12½ ft. per sec.

Since the passage of the maximum possible water to the underground gravel is of great economic importance, it will be necessary to construct the improved channel so as to leave the bottom open to seepage. Flood velocities of close to 25 ft. per sec. may be expected, which would be likely to erode the bottom. It is therefore proposed to reduce the grade of the stream to 0.4% by means of weirs—similar to the Indian diversion weirs—built in the channel at intervals.

In addition to the retarding dams recommended by me for flood prevention, I also wish to emphasize the need of the construction of a considerable number of rock-fill dams 20 to 50 ft. high, by blasting down rocks from overhead cliffs, in this way creating permanent but porous cross-structures in the cañon. There will be no permanently retained water storage behind these dams. The retarding effect will be supplemented undoubtedly by forcing great quantities of water into all the fissures, crevices and porous material within the action of the head created by these barriers, so that they will materially help the underground supply.

Engineering Literature

Passing of a Notable Journal

The *Journal of the Association of Engineering Societies*, after 34 years of useful life, ceased publication with the December issue. In its early years this journal had a standing in engineering literature second only to the proceedings of the national societies. For a time more than a dozen city and state engineering societies scattered all over the continent from Boston to San Francisco coöperated in the publication of the *Journal*. The controlling reason for the final abandonment of the enterprise was the desire of most local societies at the present day to publish a journal of their own. Advertising furnishes the sinews of war for practically all publications, and the journal of a local society, notwithstanding its limited circulation, can obtain a local advertising patronage that a coöperative publication reaching a larger field is unable to secure.

The work done by the *Journal* for many years—making the important papers read before local engineering societies available to the profession—represents a valuable service, and those who have been responsible for its conduct deserve credit. At the time the *Journal* was established (1881) practically none of the societies that joined in its publication were financially able to undertake so large an enterprise as publishing a journal of their own. A dozen societies coöperating, however, were able to furnish material from the best of the papers read before them, which made a most creditable and useful publication.

Those who recall the first years of the *Journal* will agree that another reason for its early success and for the prestige then gained that helped to support it through succeeding years was the energy and ability expended upon it by the late Prof. J. B. Johnson, a man whose great services to the profession during his too short span of active life will long be remembered.

Expert Dealer in Second-Hand Engineering Books

A prominent engineer in the Middle West sends us a letter calling attention to the need of a central exchange for the purchase and sale of back volumes of *Engineering News* and other technical periodicals valuable for reference, and of engineering libraries.

Here are a need and an opportunity that some engineer ought to recognize. We say engineer, because the ordinary dealer in second-hand books has not enough knowledge of values to render sufficient service to make the business profitable. Very likely such a business might not yield a profit that would make it attractive to a young and ambitious man. It ought, however, to do considerably more than pay its expenses. Some engineer with a liking for books and who has passed the age when he enjoys the hard routine work of the profession might well earn a good living in such a business and render besides a distinct service to the profession.

There is now a very large number of public libraries which should contain a good assortment of engineering reference books, in addition to the reference libraries of engineers in private practice. There should be a steady demand for second-hand books and bound volumes of periodicals from all such libraries; and such a demand would doubtless be stimulated if a known source of supply were available. On the other hand, through deaths and business changes the libraries accumulated by engineers frequently become available for purchase.

One advantage of a business of this sort is that much of it could readily be handled on a commission basis, shipments of books being made direct from the seller to the purchaser, so that the amount of capital necessary to invest in it would be comparatively small.

CORRESPONDENCE

Need of Standard Terms in Sewage-Disposal Work

Sir—In the last ten years or so developments in the art of sewage treatment and disposal have been rapid, and it is not strange that during this development period different names or terms have been given to, or used in, describing some particular device or process of treatment. A few illustrations will serve to point out how desirable it would be if, for any given device or process, one standard name or term only could be used.

Thus, an Imhoff tank is also called an Emscher tank, a two-story settling tank, a two-story septic tank and an Imhoff septic tank. Grit chambers are sometimes called detritus tanks. And if we consider the latest development in the art of sewage treatment—that is, the treatment of sewage with activated sludge—we find this method spoken of also as forced aëration. The tank in which the treatment is carried out is often called an activated-sludge tank, an aëration or aërating tank and also an aëro tank.

Again, the names trickling filter, sprinkling filter and percolating filter are used synonymously in America, while in England this same type of filter is called a bacteria bed. The writer is perhaps partly responsible for the use of the term sprinkling filter, owing to the fact that it was decided to give this name to the filters in the sewage-treatment works which were built some ten years ago under his direction at Columbus, Ohio, these being the first large works designed in this country to use that type of filter. As the sewage was to be sprinkled, or sprayed, over the surface of the filter, it was then thought that the term sprinkling filter would be the best one to adopt. The writer is inclined to believe now, however, that the term trickling filter is a much better one, as it conveys an idea of how the filter operates, independently of how the sewage is applied to the surface of the filter.

That others evidently recognize the need of a set of standard names or terms for use in sewage disposal may be seen from the following paragraph taken from a standard treatise on that subject:

> The following definitions are introduced here to avoid confusion as to the meaning of certain terms. The word rack signifies screening apparatus consisting of parallel bars. The word grating means screening apparatus composed of two sets of parallel bars, the sets intersecting at right angles. The word screen indicates either wire cloth or a plate of metal perforated with holes of small size. By wire racks will be designated the few screens consisting of parallel wires stretched tightly between frames. If the racks are stationary they will be termed fixed, and if they are capable of motion they will be termed movable; the same classification will be applied to screens.

While engineers may not all agree as to whether the terms adopted in this treatise for different kinds of screening apparatus are the best that can be selected or whether new words need to be coined, nevertheless here is a definite attempt to use one name or term for some particular device; and this attempt is decidedly a step in the right direction.

In the treatise referred to, the materials removed by racks, gratings and screens are all classed as screenings. In the writer's opinion the term screenings is the best one to use to describe all such materials as are removed by screening apparatus, of whatever type. He is free to admit, however, that he has not yet become entirely accustomed to the terms rack and grating. There invariably comes to his mind the thought that if the materials removed by a screen are called screenings, would not the materials removed by a rack be called rackings? And following this line of thought still farther, if the term grate had been used instead of grating, would not the materials removed by a grate then naturally be called gratings?

The writer, in expressing the thoughts which involuntarily came to his mind when first reading about racks, gratings and screens, means no disrespect whatsoever to the treatise referred to, as he considers it one of the best, if not the best, which has been published on the subject of sewage treatment and disposal; and he realizes that the terms chosen must have been decided on only after the most careful thought. His only purpose in referring to the terms used in this treatise to describe different kinds of screening apparatus is to call to the attention of sanitary engineers the necessity of getting together on, and of adopting, a set of standard names or terms for use in sewage-disposal work and of then using these terms, even if some of them do not entirely meet an engineer's personal point of view.

The great desirability of having a set of standard names or terms was brought home to the writer more strongly than ever while reading the treatise referred to, and the plan followed in that treatise of using one name or term only for any one given device, so far as possible, is greatly to be commended.

It seems to the writer as if it would be highly desirable for some suitable engineering society to take steps to secure the adoption of a set of standard names and terms for use in sewage-disposal work. If there only was in this country a national society consisting of members interested especially in the subject of sewage treatment and disposal, similar to the Association of Sewage-Works Managers in England, then the work of getting up a standard could well be done by such a society. In the absence of such a society, however, the work might be undertaken by the Sanitary Engineering Section of the American Public Health Association or the Sanitary Section of the Boston Society of Civil Engineers or by joint action of the two.

That at least one society, and a national one at that, recognizes the necessity of having standard definitions of terms used in certain branches of work may be seen by referring to the 1915 Year Book of the American Society of Testing Materials, in which are given standard definitions of terms used in paint specifications, of terms applicable to materials relating to roads and pavements and of terms relating to structural timber and sewer pipe.

While the above discussion has been limited to a plea for a set of standard names or terms for use in sewage disposal, nevertheless the necessity exists for the use of standard terms also in both water-works and refuse-disposal engineering—in fact, in all branches of sanitary work—and if either or both of the previously mentioned societies, or any other society or association of engineers, or the technical press should make up and adopt a set of standard names or terms for use in the several branches of sanitary engineering, not only would the thanks of all sanitary engineers be earned, but also of engineers interested in other classes of work and of laymen who often have sanitary problems brought before them for consideration.

JOHN H. GREGORY.

170 Broadway, New York City, Jan. 29, 1916.

REVIEWS AND NOTES

Materials of Engineering

REVIEWED BY CLYDE T. MORRIS*

THE ELASTICITY AND RESISTANCE OF THE MATERIALS OF ENGINEERING—By William H. Burr, M. Am. Soc. C. E., Professor of Civil Engineering in Columbia University. New York: John Wiley & Sons. Seventh edition, thoroughly revised. Cloth; 6x9 in.; pp. xix + 928; illustrated. $5.50 net.

The seventh edition of this work has been largely rewritten and revised and presents the subject in a much clearer and more logical style than did the previous edition. The book contains about 140 fewer pages than the old edition, due to the omission of the tables from the Cambria Steel Co.'s handbook and copies of various standard specifications, which are easily obtained by the student and are much more convenient to use in separate form.

The book is divided into two parts—I, Analytical; II, Technical—the intention evidently being to cover the subject of the mechanics of materials in the first part and to give the practical applications, together with the results of tests, in the second part. This division makes it difficult in some cases to get a comprehensive grasp of a subject from the text, as part of it will be found in one chapter and part in another. The flexure of long columns is an instance. In Chapter II is given the elementary theory, and the practical formulas and methods of design are not given until Chapter X.

Part I has been partly rewritten and enlarged by about 80 pages. An extended discussion of the fundamental relations of stresses, including the ellipse and ellipsoid

*Professor of Structural Engineering, Ohio State University, Columbus, Ohio.

of stress, has been added to Chapter I, and old Chapter II has been expanded into two chapters by adding considerable matter to the treatment of hollow cylinders and spheres. The description of combined-stress conditions in Chapter IV is especially good.

In Part II, Chapters VII and VIII, "Tension" and "Compression," present the practical side of the matter in good shape. Chapter IX, "Riveted Joints and Pin Connections," gives very little attention to pin connections; and part of the discussion of riveted joints relating to the bending of the rivets in butt joints with two splice plates is obsolete, as it neglects entirely the friction between the plates, which experiments have shown to be the main resisting factor for loads up to the usual working stresses.

Chapter X, "Long Columns," gives a review of the usual column formulas and the more recent tests of columns. Chapters XI and XII, on shearing, torsion and bending, have not been greatly changed. The part relating to the stresses in short solid beams, such as bridge pins, is especially good.

Chapter XIII, "Concrete-Steel Members," has been greatly enlarged and the experimental data brought down to date. Articles on T-beams and reinforced-concrete columns have been added. In his preface the author states regarding this chapter: "The analysis given is general, but simple and free from the superfluous and labor-increasing accretions which for some not obvious reasons, have found place in some of the commonly used formulas."

After reading this, it was with genuine disappointment that the writer waded through the involved mathematical analysis of the stresses in reinforced-concrete beams given in this chapter. The analysis is given for the most general case of a double reinforced T-beam in which both the compression and the tension in the stem of the beam are taken into account, and then the usual working formulas are derived by making certain factors equal zero. The treatment of shearing stresses and web reinforcement is good, as is also the treatment of reinforced-concrete columns.

Chapter XIV, "Flanged Beams," is good. Chapter XV gives a complete design for a deck plate-girder railroad bridge, according to the American Railway Engineering Association specifications.

Chapter XVI "Miscellaneous Subjects," includes among others a good discussion of the stresses in hooks, helical and spiral springs, eccentric loading, oblique or general flexure, stresses in flat plates, and the method of least work applied to the stresses in a bridge portal. Chapters XVII and XVIII, on "Fatigue of Metals" and "Flow of Solids," are not changed from the old edition.

Three appendices are added, the material in which it would seem to the writer might just as well have been included in the proper place in the text. The title of Appendix I is identical with that of Chapter I of the book. Appendix II gives Clavarino's formula for the stresses in thick hollow cylinders, and Appendix III gives an account of some tests of the resisting capacity of natural and artificial ice.

The greatest objection to the book is its lack of system in notation. A symbol may be given a meaning in one article and have an entirely different meaning in a preceding article to which reference is made. For instance, in Art. 82 the deflection is denoted by Δ, and in Art. 27, to which reference is made for the formula, the deflection is denoted by w. Also in equation (20), Art. 91, d is the depth of the beam, while in equation (8), Art. 15, to which reference is made for the derivation of equation (20), d is the distance from the extreme fiber to the neutral axis. These variations in notation are very confusing, especially as the meanings of the symbols are dispersed throughout the text and are not always easily found.

It is surprising that the chapter on concrete-steel members has not been revised so that the notation will agree with that recommended by the Joint Committee on Concrete and Reinforced Concrete. The notation used is not uniform, even throughout the chapter, and its lack of conformation renders the chapter very difficult to read, especially to one accustomed to the ordinary usage.

The work should make a valuable reference book for the practicing engineer, as the interpretations of tests are generally sound and the suggestions as to details of design are good.

Building-Cost Figures

THE BUILDING ESTIMATOR'S REFERENCE BOOK: A Practical and Thoroughly Reliable Reference Book for Contractors and Estimators Engaged in Estimating the Cost of and Constructing All Classes of Modern Buildings, etc.—By Frank R. Walker. Chicago, Ill. (30 North Michigan Ave.): The Author. Flexible leather; 4x7 in.; pp. v + 612; illustrated. $10.

The most striking feature of this book is that it costs $10, although from its outward appearance and comparison with similar books it should not cost more than a quarter of that amount. Whether it is worth $10 or not must be a matter of opinion. It does contain a vast number of cost data, a great many of which do not, as is usual, vary tremendously with individual jobs. The figures are reduced to their lowest terms and stated in the briefest possible fashion for clearly differentiated cases, and it is no doubt a fact that many builders or contractors would find such a collection well worth the price charged for the book.

The one distinguishing characteristic of the volume is the broad field covered by the figures. They start with general contracting figures—such as overhead expenses, erecting and excavating, caissons, piles, concrete and reinforced concrete, brick masonry, stone masonry, fireproofing—and go through the minor details of building construction—such as carpentry, millwork, plastering, doors, windows, sheet-metal work, glass, glazing, painting, plumbing, electric wiring, etc.

If the user is of sufficient judgment to convert these figures to his local requirements and variations, he will undoubtedly find the book of great value.

A Story of Arctic Adventure

ANNUAL REPORT OF DEPARTMENT OF THE NAVAL SERVICE OF CANADA, 1914-15—Ottawa, Canada. Paper; 7x10 in.; pp. 138. 10c.

This report contains the diary of Captain Bartlett, who accompanied Peary on his expedition to the north pole and who was captain of the "Karluk," the ship used by the Stefansson Arctic exploring expedition that started in 1913 to explore the regions to the north of Bering Strait. The "Karluk" was crushed in the ice in the Arctic Ocean on Jan. 11, 1914. The narrative of Captain Bartlett's journey to the mainland and thence back to Bering Strait to obtain rescue for the other members

of the party, as related in his diary, is a most interesting one.

The report also contains accounts of the ice conditions in Hudson Bay and Strait in 1914, of especial interest in connection with the project for carrying on ocean traffic by the Hudson Bay Ry. route. The Canadian survey steamer "Acadia" made the voyage to Port Nelson, spending the months of August and September in Hudson Strait and Bay, but encountered so much ice that she was damaged to the extent of $25,000. The report relates in detail the heavy ice conditions, the serious obstructions from fog, etc., that vessels must encounter in navigating the strait and bay during the half-dozen weeks in August and September in which passage is usually possible.

Against Isolated Power Plants

POWER FOR PROFIT: Principles Governing the Use of Machinery and Labor in Modern Buildings—By Reginald Pelham Bolton, author of "Building for Profit," "Elevator Service," "An Expensive Experiment," etc. New York (55 Liberty St.): The R. P. Bolton Co. Cloth; 8x11 in.; pp. 209. $2.50 postpaid.

Any who desire an extreme statement of the case against private isolated utility-service plants need Mr. Bolton's book—although it is aimed at the real-estate operator particularly. Attempting to reach this class of expected readers probably explains the dilute matter, smooth style and *ex cathedra* presentation. While not the primary object of the book, yet no chance is lost to criticize municipal ownership. Bluntly and brutally summarized, the argument of the book runs thus:

The chances against economical isolated utility service are very great. The more machinery there is used in a given service the more necessity there is for multiplied output and the greater the need of labor. Improvements in machinery result only in higher-class labor and greater labor expense. The general extension of public-utility systems lessens the advantages of private plants and reacts on itself to reduce the cost of service. Reduction in public-utility rates reduces the value of isolated plants. New combinations of company-supplied machinery continually offer new economies that a private plant cannot give. Reductions in company rates continually reduce private-plant values, and new combinations of central-station service offer new economies that a private plant cannot produce. Privately owned machinery is very liable to bring destructive accidents. Danger of accident is large in all machine plants, and protection of private-plant employees lags behind that of men in commercial utility service. In private plants touted economies are grossly exaggerated. Burdens of deterioration and obsolescence are not easily borne by the private-plant owner and consume his capital. Real-estate owners should not dabble in a strange business.

Silo Construction in Concrete

CONCRETE SILOS: Their Advantages, Different Types and How to Build Them—By E. S. Hanson, Editor of "Cement Era." Chicago: Cement Era Publishing Co. Cloth; 5x8 in.; pp 174; illustrated. $1.

The silo has proved its value in agricultural practice. The numerous systems of its construction now advertised and promoted are sufficient evidence of that, were any structural evidence required. This book is devoted to a description of the methods of building concrete silos. Unfortunately, the author considers that special pleading for his type of structure is necessary and so devotes several chapters to showing how poor all other types are. This, of course, removes the book from the strictly technical field; but if these chapters were not included, thus eliminating the obvious prejudice, the chapters of description would be well worth while.

Elementary Thermodynamics

REVIEWED BY C. R. RICHARDS*

ENGINEERING THERMODYNAMICS—By James Ambrose Moyer, Professor, and James Park Calderwood, Associate Professor, of Mechanical Engineering, Pennsylvania State College. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. viii + 203; 71 illustrations. $2 net.

Thermodynamics has never been classed among the "snaps" in the college curriculum, and few students in courses outside of those in which the subject is required "elect" it to fill up their schedule of studies. Without doubt it is a "hard" subject, and the student who masters it must expect to do real work. However much teachers of the subject may try to smooth out the difficulties, it is doubtful whether it can ever be presented in words of one syllable.

In their preface to this latest addition to the rapidly growing list of books on thermodynamics, Professors Moyer and Calderwood assert that "for years there has been an important demand for a textbook on thermodynamics which would be brief and concise, but at the same time so clearly written as regards explanation that students of average ability in our large technical schools could read it without difficulty." It may be assumed that the authors present the volume under review as one which in their opinion fully meets this demand. An inspection of the book indicates, however, that the difficulties have been overcome in part by the omission of some of the more difficult subjects normally considered desirable or essential components of a well-rounded course in thermodynamics and by the avoidance of the highly mathematical and generally more convincing treatment found in more pretentious treatises on the subject. In general, the matter presented and the treatment employed in the book are similar to those given in a number of books on the steam engine.

The authors have not been entirely successful in the elimination of statements which are likely to be misleading to the average student. Instances are the use of the term "practically perfect vacuum" where perfect vacuum is meant; the use of "mass" instead of weight; the failure to distinguish between adiabatic changes which are isoentropic and those which are not; the statement that "it is not at all unusual to have steam leaving boilers which is not perfectly and completely vaporized"; and in the verbal, and consequently useless, discussion of Hirn's analysis, the assertion that "it is possible to determine exactly the heat added to or lost from the steam." Again the impression is given that the entropy-temperature analysis of an actual steam-engine diagram or cycle gives a correct interpretation of the distribution of heat losses for the whole cycle, when as a matter of fact it can only show correctly what occurs in the cylinder during the period between cutoff and release, in which there is a constant weight of steam in the cylinder.

The volume is divided into nine chapters as follows: "Introduction to the Theory of Heat Engines"; "Prop-

*Professor of Mechanical Engineering, University of Illinois, Urbana, Ill.

erties of Perfect Gases"; "Expansion and Compression of Gases"; "Cycles of Heat Engines"; "Properties of Steam"; "Practical Applications of Thermodynamics"; "Entropy"; "Practical Steam Expansions and Cycles"; "Flow of Fluids." Of these the most nearly satisfying is the one devoted to the flow of fluids. Some of the chapters contain matter of trivial importance, and in all of them the treatment of the subject is elementary.

Steam Power and Steam Tables

REVIEWED BY CARL C. THOMAS*

STEAM POWER—By W. E. Dalby, M. Inst. C. E., London University, Professor of Engineering at the City and Guilds Engineering College of the Imperial College of Science and Technology. New York: Longmans, Green & Co. Cloth; 6x10 in.; pp. xvi + 760; 250 diagrams. $6 net.

THE CALLENDAR STEAM TABLES—By H. L. Callendar, Professor of Physics in the Imperial College of Science and Technology, South Kensington; author of "The Properties of Steam." New York: Longmans, Green & Co. Cloth; 6x9 in.; pp. 40. Steam diagram in pocket. 80c.

The two books here considered have one thing in common—a very satisfactory set of steam tables, in both cases prefaced by Professor Callendar. The larger book will first be considered.

Those acquainted with the earlier works by Professor Dalby, including his book on the "Balancing of Engines" and various notable reports of experimental investigations, will not be disappointed in his new book. It will be welcomed by the engineering profession in general as a notable contribution to the literature of its subject. It is written with characteristic clearness and simplicity, and it covers the subject of "Steam Power" in a way that is especially suitable for rather mature students of engineering. This does not mean that the elementary treatment of thermodynamics has been neglected, but rather that the book goes somewhat farther into the various phases of the subject than students approaching engineering thermodynamics for the first time are likely to go in an elementary course. This is nothing against the book, excepting in so far as the cost of 760 pages is rather high for an elementary text.

The book is well arranged from a pedagogical standpoint. It begins with a well-illustrated chapter of some 53 pages, "General Action of a Steam Plant." This is followed by a chapter, "Steam Boilers," containing illustrations and examples of typical calculations. In this chapter the subject of combustion is well treated. An excellent discussion is given of heat transference and also of the operation of smoke-stacks. Chapter 3 is called "The Motive Power Circuit" and deals with the thermodynamics of the steam plant, introducing also typical calculations illustrating elementary theory. Chapter 4 continues the subject of Chapter 3 into the field of performance of steam engines and contains valuable data upon modern practice and methods of analyzing performance. One of the subjects most satisfactorily treated is the derivation of the general expression for the adiabatic curve, $P V^{\gamma} = C$. Teachers of elementary thermodynamics are quite likely to content themselves by stating to the student that while isothermal expansion of a perfect gas is represented by the equation $P V = C$, other forms of the expansion curve may be represented by a more general equation $P V^{\gamma} = C$. This is very unsatisfactory to the really interested student, and Professor Dalby has derived the equation for adiabatic expansion (pages 144 to 152) in a beautifully clear manner, upon the basis of the fundamental equation $E + W = 0$, in which W represents external work done by the expenditure of energy E. The book as a whole should be commended for many other examples of such fundamental treatment.

There seems to be some little confusion of symbols in the section of the book referred to, due perhaps to the use of K with subscripts to represent specific heat, instead of using it to represent equivalent foot-pounds. A reader familiar with the subject can easily make such slight corrections are are necessary. On page 208 the expression for entropy, at the top of the page, is not quite clear—"in general for any path entropy equals $\frac{Q}{T}$." It is probable that this is intended to refer only to the isothermal path.

A new heat unit has been adopted in this book, the "pound-calorie," or the amount of heat required to raise the temperature of 1 lb. of water 1° C. The wisdom of this addition of another heat unit is open to question. Our units are now so diverse that it would seem we should either adopt the metric units as a whole or else adhere to the British system. The steam tables included with Professor Dalby's book give heat and work quantities in pound-calories per pound and give parallel columns stating temperature on the Centigrade scale, starting from 0 absolute and from 0 C. respectively. These tables are the same as those published separately by Professor Callendar, and reviewed below.

Pressures are stated in pounds per square inch absolute. These tables are, as stated in the book, by Prof. H. L. Callendar, F. R. S.; and while the unit already referred to may be criticized, the derivation of the tables from Professor Callendar's characteristic equations are beautifully developed. This treatment is perhaps the most satisfactory at present available for anyone wishing to understand the source of the present steam tables. The quantities given in the tables correspond with the best data now available.

Following a chapter on "The Performance of Steam Engines" and one on "The Cooling Circuit," dealing with the subject of condensers and auxiliaries, Professor Dalby has given a chapter on his "Characteristic Energy Diagrams." In this chapter results of several tests of steam locomotives have been plotted on coördinates of indicated horsepower and pound-calories transferred across heating surface per minute. This system of analysis was described by Professor Dalby, in *Engineering* some years ago and is to be commended to students and engineers.

Chapter 7 deals with the "Dynamics of Steam Engines," including the subject of methods of governing and leading up to an excellent chapter on the balancing of engines and the motion of a train. In the work on locomotives the investigations of Prof. W. F. M. Goss are discussed quite fully, and many of his extensive tests, as well as tests made by the Pennsylvania Railroad Co., are analyzed in a very satisfactory manner.

Chapter 10 deals with "Valves and Valve-Gear Mechanism." It is well illustrated and altogether an excellent treatment of the subject, taken largely from Professor Dalby's book on "Valve Gears."

Chapters 11 and 12 deal with the flow of steam and with steam turbines. These chapters are somewhat too brief, but present the subject in excellent manner, showing

*Professor of Mechanical Engineering, Johns Hopkins University, Baltimore, Md.

methods of calculation from experimentally determined results. Professor Dalby uses the terms "impulse-pair" and "reaction-pair" in connection with turbines. This is an improvement over the word "stage," which has been a source of confusion heretofore. The stationary bucket is just as important in the Parsons turbine as is the nozzle in the impulse turbine, and it is therefore not logical to speak of one row of Parsons buckets as a stage.

The book contains a few statements which are perhaps not entirely satisfactory, but those portions will be of particular interest only to mature engineers who are able to discriminate; and such debatable points as do arise are largely matters of definition and not of scientific understanding. On page 311, in connection with condensers, it is interesting to note the confusing expression "saturates a given volume." This expression is used to indicate that the water vapor occupying the space or volume is in a saturated condition.

The book concludes with the steam tables previously referred to and a large number of examples, the answers to which are given by the author.

Professor Callendar's small book affords a very clear and well-presented set of data on the properties of steam—saturated and superheated. Parallel columns give temperatures in Centigrade and Fahrenheit units. Volumes are stated in cubic feet and cubic meters, and heat quantities are given in both Centigrade and Fahrenheit units, all in parallel columns. The heat quantities are given on the foot-pound-Centigrade system, to the use of which the criticisms made in the review of Professor Dalby's book apply. The values in the tables are tabulated on the following three systems—foot-pound-Centigrade, foot-pound-Fahrenheit and kilogram-meter-Centigrade. The tables are preceded by about 20 pages of beautifully written explanatory text.

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Water-Works of England

RETURN AS TO WATER UNDERTAKINGS IN ENGLAND AND WALES—By the Local Government Board, H. C. Monro, Secretary. London: T. Fisher Unwin. Paper; 8x13 in.; pp. xliii+599. 5s. 1d.

All piped water-supplies reaching ten houses or more were included in an inquiry ordered by Parliament in 1910. After the individual returns had been gathered and put in type, proof was sent to the various reporters and the returns corrected, for the most part, to January, 1914. The compilation was ordered printed on July 28, 1914, but apparently the European War delayed publication until 1915.

The body of the report consists first of a summarized description of each "water undertaking" in England and Wales and next of the supply to each "district," including rural parishes.

The undertakings or water-works described include those of 786 separate local authorities, the Metropolitan Water Board and 34 other joint authorities, 284 companies and 1,055 private proprietors—the latter being very small supplies, as a rule. The descriptions comprise the places supplied by each works, date of grant of parliamentary powers, source, quantity and character and general efficiency of supply, rate of filtration if any, storage capacity and average daily consumption. The hardness of the water and whether it acts on lead are given.

The particulars reported for each district having a water-supply are area, population, number of houses, both total and supplied, and the name of the owner of the works. The same table states for each parish in a rural district without a piped supply whether water is drawn from wells, springs or otherwise, together with the nature and efficiency of the supply.

Altogether a piped service is supplied to 1,101 of the 1,130 boroughs and urban districts and to 4,874 of the 12,869 parishes in rural districts.

The return is prefaced by a summary and a few recommendations for legislation, the latter including suggestions for the establishment of river boards to control water pollution and to supervise the distribution of both river and underground waters.

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British Building Data

RIVINGTON'S NOTES ON BUILDING CONSTRUCTION: A Book of Reference for Architects and Builders and a Textbook for Students (in two volumes)—Edited by W. Noble Twelvetrees. New edition, entirely rewritten. New York: Longmans, Green & Co. Cloth; 6x9 in. Part I, pp. 306; 484 illustrations. Part II, pp. 332; 395 illustrations. $2.25 each.

The main value to American readers of British books on such a subject as building construction is not so much to help them in the details of design as to indicate to them how other engineers under different conditions are solving the same problems. It is of course not necessary to emphasize the great difference between European and American practice in building. This does not mean, however, that the American cannot learn much from the older practitioner, and in acquiring this learning there is probably no better book on the particular subject than the one now under consideration. The book was first published about 40 years ago, and it had so wide a circulation in England that the publishers decided a few years ago to bring it down to date under the direction of the well-known concrete engineer, W. Noble Twelvetrees.

The revised edition, which is quite modern, includes such subjects as building regulations, timbering, excavations, scaffolding, brickwork, masonry, arches, chimneys, steel skeletons, reinforced concrete, carpentry, roofs and roofing, timber roofs, steel roofs, joinery, plastering, water-supply, gas, lighting, power equipment, etc. There is no doubt that builders could find in such a book many items that would help them in their practice.

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British Refuse Destructors

REFUSE DISPOSAL: A Practical Manual for Municipal Engineers, Members of Local Authorities, Etc.—By Ernest R. Matthews, Assoc. M. Inst. C. E., Chadwick Professor of Municipal Engineering. London: Charles Griffin & Co. Philadelphia: J. B. Lippincott Co. Cloth; 5x8 in.; pp. 160; 99 illustrations. $2 net.

A brief description of British practice in refuse burning is here presented, together with some remarks on refuse collection, on "unsatisfactory methods of disposal" by dumping on land and at sea and by "purchase by farmers," and on "crushing and converting into manure." A half dozen British types of destructors are described. There are a chapter on small installations for villages and institutions, another one on the use of clinker, two chapters on chimney construction and finally a chapter on vacuum cleaning for buildings. The book contains much less information than those by Goodrich on the same general subject, but is less expensive and considerably more recent.

Electrical Testing Explained

ELECTRICAL MEASUREMENTS AND METER TESTING: A Book in Plain English for the Student and Practical Man; Fundamental Theory, Practical Applications and Examples—By David Penn Moreton, Associate Professor of Electrical Engineering, Armour Institute of Technology, Chicago, Ill.; Frederick J. Drake & Co. Linen; 4x7 in.; pp. 328; 191 illustrations. $1.

Professor Moreton has produced an excellent little book on electrical testing, useful for nonelectrical engineers. A large amount of space is devoted to the elementary theory of electric circuits and the construction of commercial instruments. The measurements covered include resistance, inductance, capacity, current, potential, power and energy. Calibration of galvanometers, ammeters, voltmeters, wattmeters and watt-hour meters, demand indictors, etc., is described.

⁂

Automobile Engineering

THE GASOLINE AUTOMOBILE—Prepared in the Extension Division of the University of Wisconsin by George W. Hobbs, Instructor in Mechanical Engineering in the University Extension Division, and Ben G. Elliott, Associate Professor of Mechanical Engineering, University of Nebraska. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiii + 259; 253 illustrations. $2 net.

This book, according to its preface, is the outgrowth of extension work carried on by the University of Wisconsin. The text has been developed from a series of lectures given by the authors in 23 cities last winter. As might be expected, therefore, the book is designed for the average intelligent man. That the book is up to date is illustrated by the fact that 31 pages are devoted to starting and lighting systems. The treatment of carbureting systems is almost equally full.

In the compilation of any such book as this the problem is to know what to include and what to leave out. Nothing like exhaustive treatment of the subject in a single volume is of course possible, for automobile engineering has already become an art represented by a large national engineering society and a voluminous literature. On the whole the authors seem to have used discriminating judgment in the preparation of their book.

⁂

Report on Chicago Railway Electrification

SMOKE ABATEMENT AND ELECTRIFICATION OF RAILWAY TERMINALS IN CHICAGO. Report of the Chicago Association of Commerce Committee of Investigation on Smoke Abatement and Electrification of Railway Terminals. W. F. M. Goss, Chief Engineer. Chicago: Rand-McNally & Co. Cloth; 9x12 in.; pages 1,177; illustrated. $6.

By far the most extensive and thorough study ever undertaken of the pollution of city air by smoke and other causes and of what would be involved in transformation from steam to electric traction of all the railway lines within a great city is the investigation which has been carried on at Chicago for the last four years, the results of which are summarized in this book.

The investigation was made under direction of a commission, of which four members were appointed by the mayor of the city, four by the railway companies and nine by the Chicago Association of Commerce. The funds necessary to carry on the investigation were provided by the railway companies, and it is stated that something like a quarter of a million dollars has been spent. A staff of expert engineers was organized by the commission and has carried on the work with scientific thoroughness. The impartial character of the report is guaranteed not only by the character of the citizens who made up the commission, but by the high standing of the engineers who were in charge of technical matters.

In every city where problems of smoke abatement may hereafter be studied and in the office of every engineer who has to deal with problems of railway electrification, this report will be invaluable for reference. A brief summary of the conclusions was printed in *Engineering News* of Dec. 9, p. 1141.

It may be stated here that the commission's investigations showed that the smoke from steam locomotives is responsible for only one-fifth of the smoke present in the air of Chicago, and further that if electrification of the entire railway system of the city were undertaken the railways would have to invest about $250,000,000 to carry out the work.

The report contains a vast mass of statistics, tables, diagrams, etc., which is, however, only a small part of the data accumulated by the commission. The additional data will doubtless be preserved and made available for reference by engineers and others in some public library. The questions which have been so exhaustively studied at Chicago are certain to come up for discussion and investigation in other cities, and it is fortunate that authoritative data, collected and arranged by impartial observers, will hereafter be available.

⁂

German Official Socialism

SOCIALIZED GERMANY—By Frederic C. Howe, author of "The City: the Hope of Democracy"; "The British City: the Beginnings of Democracy," etc. New York: Charles Scribner's Sons. Cloth; 5x8 in.; pp. x + 342. $1.50 net.

Much interesting information on municipal, state and imperial ownership of utilities and on many phases of social welfare work in Germany is given in this book. The substance of some of the information was previously available in more or less scattered form, but the author has brought it together, vivified and illumined it from what he terms a "rather intimate knowledge of German life during the past quarter century."

The author's conception of what Germany does for its people is thus expressed in his preface:

> Germany is more intelligently organized than is the rest of the world. The individual German receives more from society. He is better protected in his daily life. The gains of civilization are more widely distributed than they are with us. His dignity and his personal liberty are on a different, and from our point of view on a lower, plane than in America and Great Britain, but his daily and hourly needs, and those of his wife and family, are better cared for. And the individual man is more efficient. He is better prepared for his life work. He enjoys a wholesome leisure life. He is assured protection from "la misère" in old age. The workhouse does not await him if he falls by the wayside.

Besides the more general discussion, the book treats of state-owned railways, canals, waterways, harbors and river shipping, mines, forests and agricultural lands and the wide extent of municipal ownership. The various forms of German state insurance are described, and the educational system is outlined. Health-protective work, city planning, municipal land owning and housing, and city government by experts—all receive attention.

The book is all the more interesting and suggestive because the author, who is an ardent believer in social democracy, finds so much to commend in monarchical socialism.

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A very interesting and valuable reference book is the general catalog of the United States Cast-Iron Pipe and Foundry Co. (Burlington, N. J.). It contains much readable matter on ancient water-works, a history of pipe founding and much detailed information about modern

water-works practice. The text also covers in detail other uses of cast-iron pipe, such as for culverts, sewers, gas and steam mains, etc. There are many useful tables; for example, tables giving the amount of lead in bell-and-spigot joints, standard thicknesses of water mains, standard dimensions of pipes and specials, etc., which relate specifically to the company's own products, while several pages are devoted to tables of general use—for the flow of water in iron pipe, friction heads for elbows, commercial pipe sizes for fire streams, contents of tanks and cisterns per foot of depth, etc. The whole forms a book of 222 pages 8½x10¾ in. in size, bound in black cloth. Needless to say, it is a book which every water-works engineer would like to have in his library.

Anyone who desires a brief review of present and possible water powers of Canada should secure one or more of the official pamphlets recently issued by the Water Power Branch, Department of the Interior of Canada, for use with the Branch's exhibit at the Panama-Pacific Exposition.

The titles of these pamphlets are as follows: "Water Powers of British Columbia," "Water Powers of the Prairie Provinces," "Water Powers of Ontario," "Water Powers of Quebec" and "Water Powers of the Maritime Provinces." They are arranged particularly for popular reading and do not go into engineering details very extensively but furnish a good basis of departure for further investigations.

Owing to a typographical error the number of pages in Ernest McCullough's "Practical Surveying," noticed on p. 1176 of *Engineering News* of Dec 16, 1915, was stated as 42 instead of 402.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION: Proceedings of Annual Convention Held at Atlantic City, N. J., June 9-11, 1915—Vol. 48. Chicago (1112 Karpen Building): Joseph W. Taylor, Secretary. Cloth; 6x9 in.; pp. 736; illustrated.

ANALYTICAL MECHANICS, for Students of Physics and Engineering—By H. M. Dadourian, Instructor of Physics in the Sheffield Scientific School of Yale University. Second edition, revised and enlarged. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. xiv + 431; 148 illustrations. $3 net.

ANNUAL REPORT OF DIRECTOR OF RAILWAYS OF CHOSEN, 1913-14—Ryuzan, Chosen: Railway Bureau of Government-General of Chosen. Paper; 7x10 in.; pp. 85.

ANNUAL REPORT OF THE BOSTON TRANSIT COMMISSION—Boston (15 Beacon St.): B. Leighton Beal, Secretary. Cloth; 6x9 in.; pp. 102; illustrated.

ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY FOR 1915—Washington, D. C. Paper; 6x9 in.; pp. 186; illustrated.

ANNUAL REPORT OF THE LIBRARIAN OF CONGRESS and the Report of the Superintendent of the Library Building and Grounds for 1915—Washington, D. C.: Superintendent of Documents. Cloth; 6x9 in.; pp. 221. 40c.

ANNUAL REPORT OF THE PHILIPPINE COMMISSION, 1914—Washington, D. C.: War Department. Cloth; 6x9 in.; pp. 426.

DAMS AND WEIRS: An Analytical and Practical Treatise on Gravity Dams and Weirs; Arch and Buttress Dams; Submerged Weirs, and Barrages—By W. G. Bligh, M. Inst. C. E., Inspecting Engineer of Irrigation Works, Department of Interior, Canada. Chicago: American Technical Society. Cloth; 6x9 in.; pp. 206; 122 illustrations. $1.50.

EARTH RESISTANCE AND ITS RELATION TO ELECTROLYSIS OF UNDERGROUND STRUCTURES—By Burton McCollum, Electrical Engineer, and K. H. Logan, Assistant Physicist. Washington, D. C.: United States Bureau of Standards. Technologic Paper 26. Paper; 7x10 in.; pp. 48; illustrated.

ELECTRIC RAILWAY ENGINEERING—By C. Francis Harding, Fel. Am. Inst. E. E., Professor of Electrical Engineering, Director of Electrical Laboratories, and Dressel D Ewing, M. Am. Inst. E. E., Assistant Professor of Electrical Engineering, Purdue University. Second edition fully revised, enlarged and reset. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xv + 416; 190 illustrations. $3 net.

EXAMPLES IN MAGNETISM, for Students of Physics and Engineering—By F. E. Austin, Author of "Examples in Alternating Currents," "How to Design, Make and Operate High-Pressure Transformers," etc. Hanover, N. H.: The Author, Box 441. Second edition. Flexible leather; 5x8 in.; pp. 90; 27 illustrations. $1.10 postpaid.

EXPERIMENTAL WIRELESS STATIONS: Their Theory, Design, Construction and Operation—By Philip E. Edelman, author of "Inventions and Patents," "Simple Experiments in Chemistry," etc Third revised edition. Minneapolis, Minn. (1802 Hague Ave.): The Author. Cloth; 5x8 in.; pp. 272; 98 illustrations. $1.50.

GEOLOGY AND UNDERGROUND WATERS OF THE NORTHERN LLANO ESTACADO—By Charles Laurence Baker, Austin, Tex.: Editor of University Publications, University of Texas. Bulletin 57. Paper; 6x9 in.; pp. 225; illustrated.

INDIANA SANITARY AND WATER-SUPPLY ASSOCIATION: Proceedings of Annual Convention at Indianapolis, Feb. 23 and 24, 1915. Indianapolis (State House): Dr. W. F. King, Secretary. Paper; 6x9 in.; pp. 150.

INDUSTRIAL USES OF FUEL OIL—By F. B. Dunn. San Francisco, Calif.: Technical Publishing Co. Cloth; 5x8 in.; pp. 235; 108 illustrations. $3.

IRRIGATION PRACTICE AND ENGINEERING: Vol. III, Irrigation Structures and Distribution System—By B. A. Etcheverry, Head of the Department of Irrigation, University of California. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xv + 438; 186 illustrations. $4 net.

LIVE-LOAD STRESSES IN RAILWAY BRIDGES, with Formulas and Tables—By George E. Beggs, Assoc. M. Am. Soc. C. E., Assistant Professor of Civil Engineering in Princeton University. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. v + 123; 16 illustrations; 21 tables. $2 net.

MASTER CAR BUILDERS' ASSOCIATION: Proceedings of Annual Convention Held at Atlantic City, N. J., June 14-16, 1915—Vol. 49, Parts I and II. Chicago (1112 Karpen Building): Joseph W. Taylor, Secretary. Cloth; 6x9 in.; pp. 1972; illustrated.

THE METALLOGRAPHY AND HEAT TREATMENT OF IRON AND STEEL—By Albert Sauveur, Professor of Metallurgy and Metallography in Harvard University and the Massachusetts Institute of Technology. Second edition. Cambridge, Mass.: Sauveur & Boylston. Cloth; 8x11 in.; pp. xvi + 486; 438 illustrations.

PETROLEUM AND NATURAL-GAS RESOURCES OF CANADA: Vol. II, Description of Occurrences—By Frederick G. Clapp and Others. Ottawa: Mines Branch, Canada Department of Mines. Paper; 7x10 in.; pp. 404; illustrated.

POLE AND TOWER LINES, for Electric Power Transmission—By R. D. Coombs, M. Am. Soc. C. E. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. viii + 272; 162 illustrations. $2.50 net.

PROCEEDINGS OF THE CONFERENCE ON VALUATION, Held at Philadelphia, Nov. 10-13, 1915. [Published in "The Utilities Magazine," January, 1916.] Philadelphia (1009 Finance Building): Utilities Bureau. Paper; 9x12 in.; pp. 227. $2.

Among the topics covered are the reproduction and original cost theories of valuation; franchise, land and going value; depreciation, unit prices and priced inventories.

PUBLICATIONS OF UNITED STATES BUREAU OF MINES—Washington, D. C. Paper; 6x9 in.; illustrated.

Sampling and Analyzing Flue Gases—By Henry Kreisinger and F. K. Ovitz. Bulletin 97. Pp. 70.

Shot Firing in Coal Mines by Electricity Controlled from Outside—By H. H. Clark, N. V. Breth and C. M. Means. Technical Paper 108. Pp. 36.

PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY—Washington, D. C. Paper; 6x9 in.; illustrated.

Water-Supply Papers—No. 351, Surface Water-Supply of the United States, 1913; Part I, North Atlantic Coast Basins—By Nathan C. Grover, Chief Hydraulic Engineer; C. C. Covert and G. C. Stevens, District Engineers. Pp. 189. No. 373, Water Resources of Hawaii, 1913—By G. K. Larrison. Pp. 190. No. 400-A, The People's Interest in Water-Power Resources—By George Otis Smith. Pp. 8.

Mineral Resources of the United States—No. 16, The Production of Iron Ore, Pig Iron and Steel in 1914—By Ernest F. Burchard. Pp. 477-539. No. 17, Copper in 1914—By B. S. Butler. Pp. 541-596. No. 31, The Production of Coal in 1914—By C. C. Lesher. Pp. 587-746. No. 32, The Production of Natural Gas in 1914—By John D. Northrop. Pp. 747-818. No. 33, The Stone Industry in 1914—By G. F. Loughlin. Up. 819-891. No. 34, Petroleum in 1914—By John D. Northrop. Pp. 893-1098.

SURFACE OILING OF EARTH ROADS—Prepared by B. H. Piepmeier, Maintenance Engineer. Springfield, Ill.: State Highway Department. Bulletin 11. Paper; 6x9 in.; pp. 28; illustrated.

VORLESUNGEN UEBER THEORIE DES EISENBETONS, im Anhang Hilfstabellen, die deutschen Bestimmungen von 1915 mit Auslegungen, die oesterreichischen und die schweizerischen Vorschriften—Von Karl Hager, o. Professor an der Technischen Hochschule, Muenchen. Munich and Berlin: R. Oldenbourg. Cloth; 8x11 in.; pp. viii + 382; 330 illustrations.

Field and Office

Special Plant for Handling Spoil from Shafts

A special arrangement for removing spoil from subway shafts and for conveying it to the dock is being employed successfully by Holbrook, Cabot & Rollins on their section of the Broadway subway in New York City. The views show the plant at 39th St., and there is a similar arrangement at 41st St. just west of Broadway. The most important departure lies in equipping the large skips, or dump buckets, with wheels so that they can be easily moved about.

During the absence of the motor truck that conveys the skips the electric crane stationed on the overhead bridge, shown, raises loaded skips and stores them on the upper platform. When the truck returns and discharges its six empties onto the lower platform, by means of a movable bridge connecting platform and truck, the inner end of this bridge is raised to the upper level. The loaded skips are then rolled down the bridge and onto the truck. The skips are not always loaded onto the truck from the upper level, but are frequently handled directly from the shaft onto the truck, by means of the electric crane.

FIG. 1. ELEVATED CRANE HOISTING A WHEELED SKIP FROM A SUBWAY-EXCAVATION SHAFT

Eight Tests on Built-Up Timber Columns

By H. D. Dewell*

Built-up timber columns are very extensively used by carpenters, sometimes from necessity because of inability to secure the solid sticks, but more frequently on account of the ease of handling the smaller pieces comprising the columns. A third reason is the belief somewhat prevalent in the minds of the more ignorant that the built-up stick is stronger than the solid stick.

There are, however, occasions when it is necessary to use laminated columns, as in the curved compression chords of certain forms of arched trusses. It then becomes of moment to know what is the strength of such built-up columns, in order that they may be used intelligently.

It is believed justifiable to state that in all probability no built-up column as constructed in actual work is as strong as a solid one of equal dimensions. This is due to the fact that sufficient nailing is practicall impossible

*58 Sutter St., San Francisco, Calif.

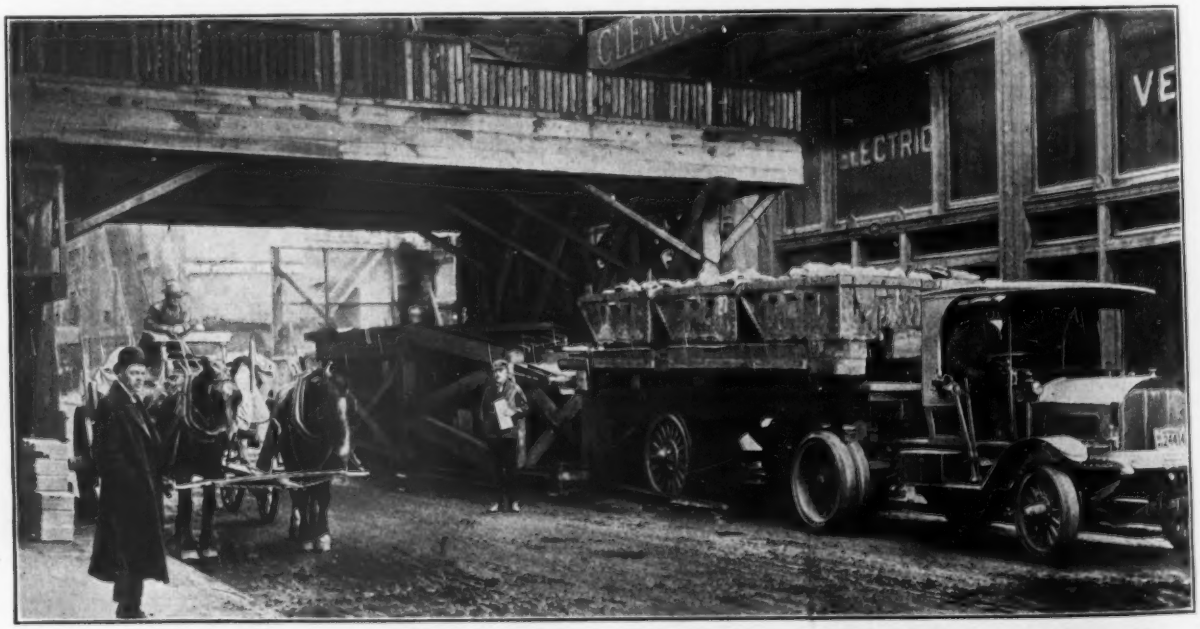


FIG. 2. TRUCK WITH SPECIAL BODY JUST LOADED BY THE CRANE AND PLATFORM ARRANGEMENT OF HOLBROOK, CABOT & ROLLINS ON NEW YORK SUBWAY CONTRACT

to secure. In addition such composite columns usually contain joints between their ends, in which imperfect butts occur.

Professor Burr in his "Elasticity and Resistance of the Materials of Engineering" says, in speaking of the Watertown tests on compound columns:

> A number of tests, however, were made on compound columns formed by bolting together from two to three rectangular sticks with bolts and packing or separating blocks at the two ends and center. The bolts were parallel to the smaller sectional dimensions of the component sticks. As was to be expected, those compound columns possessed essentially the same ultimate resistance per square inch as each component stick considered as a column by itself . . . a comparison of these results shows that these composite or built-up columns were the same in strength per square inch with the single sticks of which they were composed, the laths being considered single columns.

Composite columns built up of 2-in. material and thoroughly spiked together may undoubtedly be taken as giving a much stronger section than the sticks bolted at ends and center, as described in the preceding paragraph. What reduction in strength should be allowed for in a built-up spiked column is a question not at all definite and depends to a large extent on the arrangement

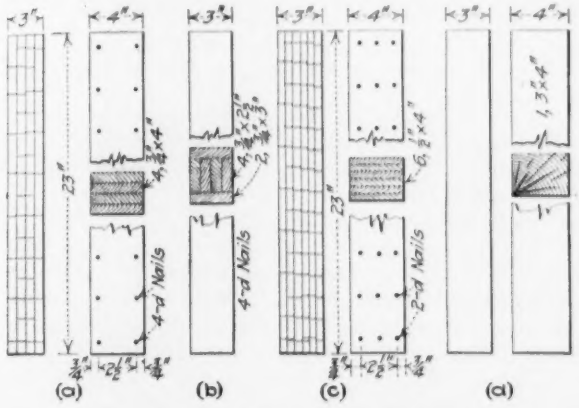


FIG. 1. DETAILS OF TEST COLUMNS

of the individual sticks and the extent and thoroughness of the spiking. A column built as in *b*, Fig. 1, is obviously much stronger than the same section when arranged as in *a*, Fig. 1.

Tests Made at Panama-Pacific Exposition

To throw some light on the subject the writer recently tested a few small columns built up as shown in Figs. 1 and 2. For comparison two columns of the same cross-section, but of solid timbers, were also tested (*d* in Fig. 1).

These tests were made on a 150,000-lb. capacity Olsen compression machine in the exhibit of the Tinius Olsen Testing Machine Co. at the Palace of Machinery, Panama-Pacific International Exposition, through the courtesy and interest of Mr. Olsen. The machine has an attachment for making autographic records of the deformation of the test pieces, the curves of which are reproduced in Fig. 3.

Eight small columns in all were made, two of solid timber, and the others built up. They were 3x4 in. in section, of surfaced No. 1 common Douglas fir, with ends true and square and surfaced. Unfortunately one of the two columns *b* disappeared, and only one specimen of this

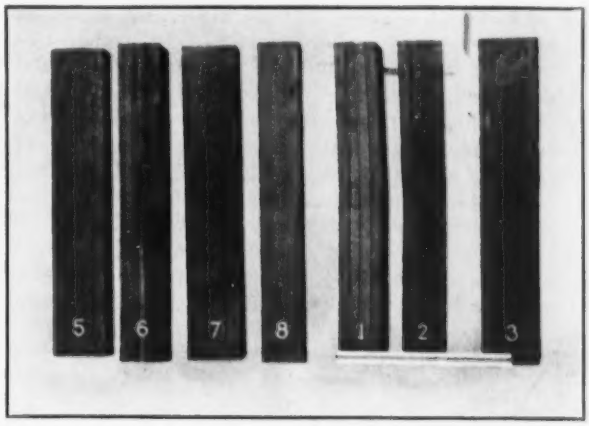


FIG. 2. VIEWS OF THE COLUMNS AFTER TESTING

type was tested. The specimens after test looked as shown by the view, Fig. 2.

The one column of Type *b* was found to be as strong as the solid stick. At the ultimate load, however, the individual pieces separated somewhat. The failure in this column was a combination of crushing, owing to straight compression, and of tension, due to bending of the individual sticks.

While the two sticks *a*, built up of four 4x¾ pieces, had a strength almost as great as the solid sticks, the failure was by bending of the column in the direction of the thickness of the individual boards. This failure was quite sudden.

The two columns of Type *c*, composed of six 4x½-in. boards, failed by bending very suddenly and without warning, the individual sticks bending in the direction of their thickness and the whole column bowing out some 3 or 4 in.

Spiking and Coverplating Important

While these tests are not sufficient in number and are too small in size to formulate working values for composite columns, they indicate to what a great extent the nailing is effective, and that wherever possible the sections should be constructed with "cover plates," well spiked into the edges of the inner boards or planks, similar to *b*, Fig. 1.

The writer has taken occasion at all times when the opportunity offered to examine the spiking or bolting of laminated columns in actual construction and has almost in every case found it to be far from sufficient to develop the full strength of the section.

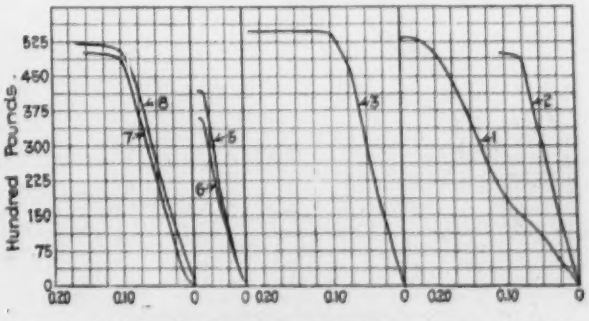


FIG. 3. LOAD-DEFORMATION CURVES FOR COMPOSITE TIMBER COLUMNS

Abscissas are deformations in inches

It is also very common, at least locally, for architects to show sections of timber columns on their plans as built up of 2-in. stock when there is no reason why solid timbers should not be used at practically no additional expense. This comment does not apply to the doubling of studs under concentrated loads in partitions where such columns are supported laterally by the wall bridging. It does apply, however, to all important posts, and especially corner posts which may be stiffened laterally from only one side. Even the sheathing cannot be counted on for side stiffness to too great an extent, as a careful investigation of the actual number and size of nails employed in such a case will usually show the nailing to be extremely meager.

It should be remembered that these tests do not take account of the time factor as affecting the strength of the column, not alone by deterioration of the wood, but also by the loosening of the nails caused by shrinkage of the timber.

The writer wishes to thank Mr. Olsen and his assistant, E. L. Peck, for their kindness and interest in carrying out the tests, and trusts that the results may be of some interest to those doing construction work.

Home-Made Plant That Helped Build the Kensico Dam

By Wilson Fitch Smith*

It happens not infrequently that in engineering construction a sudden need occurs for a special tool for a special piece of work. Then the ingenuity of the practical engineer asserts itself. Instead of sending to a distance for more expensive plant and waiting an indefinite time, he looks over his idle plant and scrap heap and in a few hours produces the required machine. There is hardly a contracting job directed by an able superintendent that does not witness several of these home-made affairs which have done efficient work and perhaps "saved the day" for the contractor.

*Division Engineer, Board of Water-Supply, New York City.

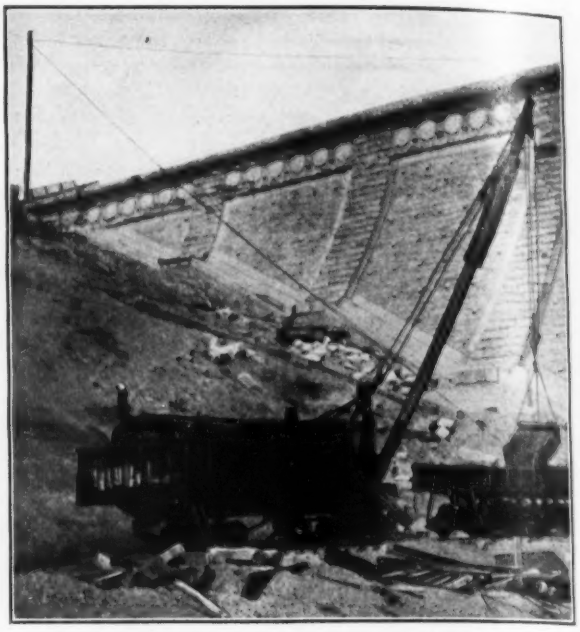


FIG. 1. STEAM SHOVEL (DIPPER AND BOOM REMOVED) Equipped with 55-ft. timber boom, to serve as traveling crane

The work on the Catskill Aqueduct saw many such inventions. The photographs illustrate three that were developed by George H. Angell, Superintendent for H. S. Kerbaugh, Inc., on Contract 9 for the Kensico dam, each performing satisfactory service.

When the need arose for an additional traveling crane, an idle 65-ton steam shovel was relieved of its dipper and boom and equipped with a 55-ft. timber boom, as shown in Fig. 1. This was used for handling material trimmed from excavation slopes and also did service in the concrete-block yard, moving the finished blocks from the forms to the storage piles.

A portable sand screen was constructed by putting together a small rotary-screen frame, a gravity concrete-mixer gage pan, parts of a belt conveyor (all reclaimed

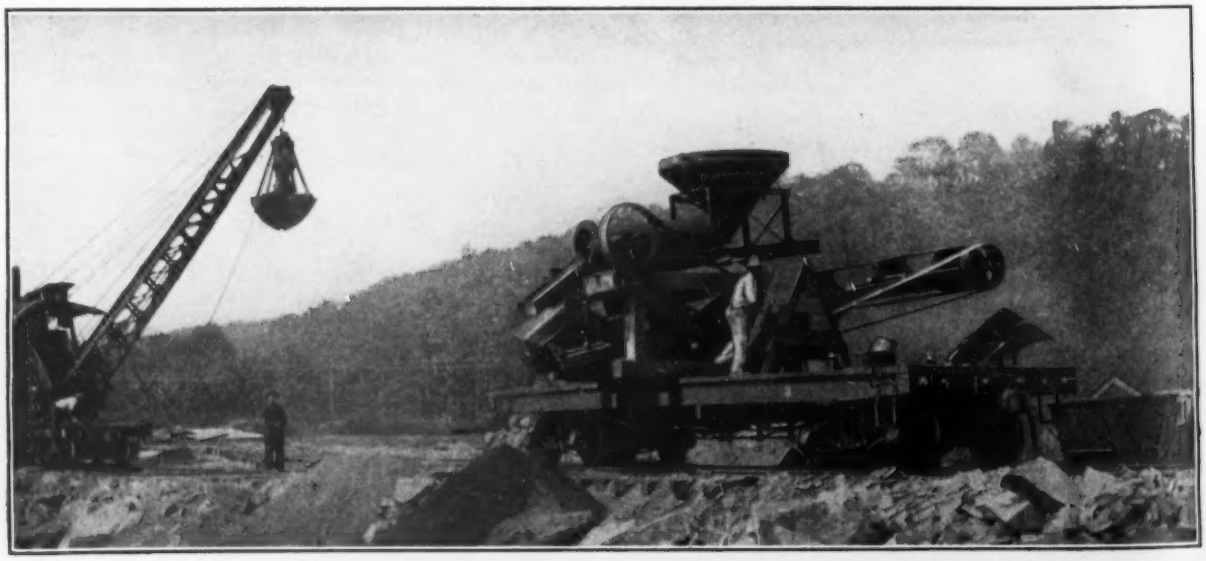


FIG. 2. A PORTABLE SCREEN WHICH HANDLED 5,000 YD. OF SAND IN ONE SEASON

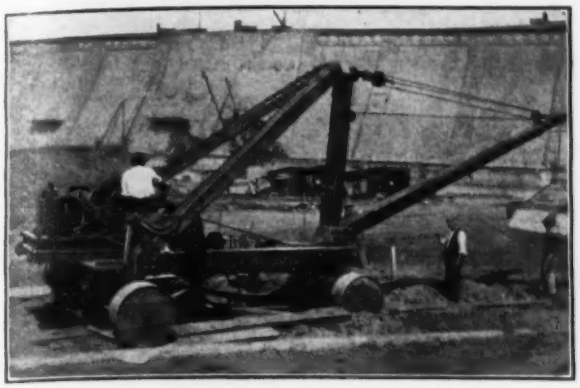


FIG. 3. A TRAVELING DERRICK BUILT FROM SCRAPS

from the scrap heap) and an idle 5-hp. motor. This arrangement (see Fig. 2) mounted on a flat car handled 5,000 cu.yd. of sand in one season.

A portable derrick for setting concrete curbs was evolved from an idle 15-hp. electric hoist, some derrick fittings and second-hand timbers. This excellent machine not only could haul itself along on plankways, but could also draw the curb from the nearest railroad track to the place of setting. In 97 days 13,000 lin.ft. of curb was set.

Table and Chart for Wind-Pressure Formulas

By Harry B. Wrigley*

The normal pressure upon an inclined surface varies with the inclination of the roof. Three formulas for this variation are in common use: Hutton's (derived in 1788),

$$P_n = P \sin A^{1.82 \cos A - 1}$$

Duchemin's (derived in 1829),

$$P_n = P \frac{2 \sin A}{1 + \sin^2 A}$$

straight line (recent),

$$P_n = P \frac{A}{45}$$

where

P = Pressure on a vertical surface;
P_n = Pressure normal to roof surface;
A = Angle which the roof surface makes with the horizontal.

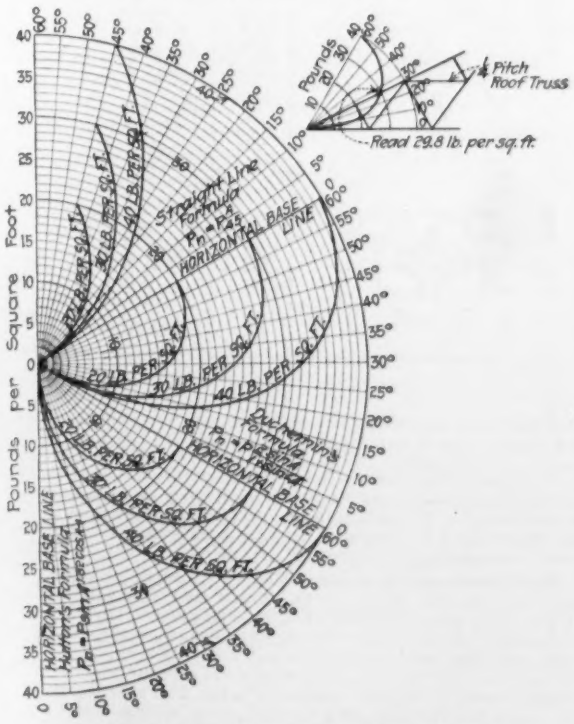
In the accompanying table the 20, 30 and 40 heading the columns represent P, and the values underneath are the corresponding P_n values for the angle A.

TABLE OF NORMAL PRESSURES OF WIND

A	Hutton			Duchemin			Straight Line		
	20	30	40	20	30	40	20	30	40
5°	2.6	3.9	5.2	3.5	5.2	6.9	2.2	3.3	4.4
10°	4.8	7.2	9.6	6.7	10.1	13.5	4.4	6.7	8.9
15°	7.0	10.5	14.0	9.7	14.6	19.4	6.7	10.0	13.3
18° 26′	8.7	13.0	17.3	11.5	17.2	23.0	8.2	12.3	16.4
20°	9.2	13.7	18.3	12.2	18.4	24.5	8.9	13.3	17.8
21° 48′	10.0	15.0	20.0	13.0	19.6	26.1	9.7	14.5	19.4
25°	11.3	16.9	22.5	14.3	21.5	28.7	11.1	16.7	22.2
26° 34′	12.0	18.0	24.0	14.9	22.4	29.8	11.8	17.7	23.6
30°	13.3	19.9	26.5	16.0	24.0	32.0	13.3	20.0	26.7
33° 41′	14.7	22.0	29.3	17.0	25.4	34.0	15.0	22.5	30.0
35°	15.0	22.6	30.1	17.3	25.9	34.5	15.6	23.3	31.1
40°	16.7	25.1	33.4	18.2	27.3	36.4	17.8	26.7	35.6
45°	18.0	27.1	36.1	18.9	28.3	37.7	20.0	30.0	40.0
50°	19.0	28.6	38.1	19.3	29.0	38.6			
55°	19.8	29.7	39.6	19.6	29.4	39.2			
60°	20.0	30.0	40.0	19.8	29.7	39.6			
60° to 90°	20.0	30.0	40.0	20.0	30.0	40.0			

Some may find the chart form more convenient than the table form. The polar-coördinate chart herewith can be applied directly to the drawing of a roof and the value of normal pressure read off at the intersection of the roof plane with the proper curve. Radial distances are the values of normal pressure. In using the chart care must be taken to place the proper line horizontal.

*19th and B St., N. W., Washington, D. C.


Pounds per Square Foot
Pounds
¼ Pitch Roof Truss
Read 29.8 lb. per sq. ft.
Straight Line Formula
Pn = P/45
HORIZONTAL BASE LINE
20 LB. PER SQ. FT.
30 LB. PER SQ. FT.
40 LB. PER SQ. FT.
Duchemin's Formula
Pn = 2P sin A / 1 + sin² A
Hutton's Formula
Pn = P sin A^(1.82 cos A − 1)

NORMAL WIND PRESSURE ON ROOFS

Triangulation Details for Bridge Survey

In the triangulation for a recently built bridge of long span two details of special design were used—an observing shelter and a tripod target. They are illustrated by sketches herewith.

The triangulation house for sheltering the instrument was a square box 5x5 ft., 6 ft. high to roof, with windows in two adjoining sides and equipped with a target fixed to the peak of the roof. It was built of 3x3-in. posts and joists and vertical 1-in. sheathing, the roof being shingled. Besides the two observation windows there was a door with lock. It was built on four posts, or hubs, set solidly at the four corners. The target, 7½x1 in., 30 in. high, was painted red and white, with a central vertical white line. It sat on a 1½-in. base 16 in. in diameter, held down by four hook-bolts. A hole in the front of the house provided for tape measurement.

The cost of two houses was about $22 for material and $30 for labor, a total of about $26 per house.

The tripod target, fully shown, was made of the following material: 3-in. top, 3 in. and 12 in. on a side, fitted with a level; 3x3-in. tapered legs, attached by 6-in.

T-hinges; leg tips formed by round-headed screws, seating in countersunk holes in old hinges nailed to the tops of three base hubs; stovepipe for windshield for the plumb-bob string; and a 6x¾-in. target 30 in high,

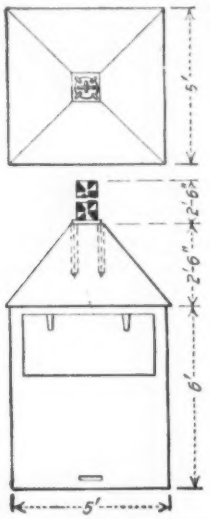


FIG. 1. OBSERVING HOUSE FOR TRIANGULATION

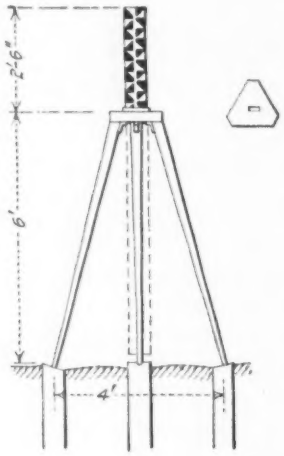


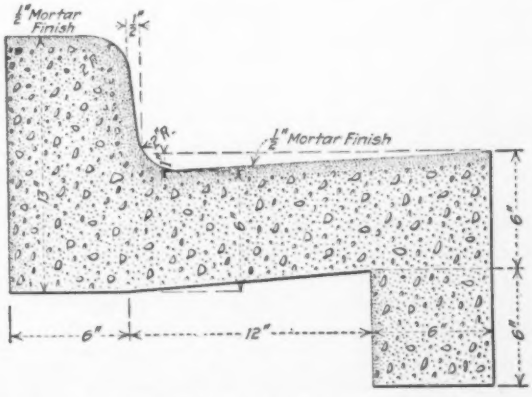
FIG. 2. TRIPOD TARGET FOR TRIANGULATION

seated on a base plate 8x8x1½ in. fastened by clamps to the tripod top.

Two tripod targets cost $5 for material and $8 for labor, or a total of $6.50 each. The type of target proved very good on long sights.

NOTES

Combined Concrete Curb and Gutter—The accompanying sketch shows the form and dimensions of the concrete curb and gutter used by A. R. Young, City Engineer of Topeka, Kan. There are many miles of this construction in the city, and it is all in excellent condition. The concrete wall, or edging, next the pavement has been found to prevent many previous troubles. This edging extends from 4 to 6 in. below the base of the pavement and permits a thorough rolling of the subgrade and of the pavement without crowding the material under the edge of the apron and cracking or displacing the curbing. The ½-in. mortar facing is placed while the concrete is green, by pushing over it a traveling steel templet, the mortar being properly distributed ahead of this machine.



COMBINED CONCRETE CURB AND GUTTER, TOPEKA, KAN.

Light-Reflecting Value of Paint—New tests of the light-reflecting value of white and colored paints are reported by Henry A. Gardner, of the Institute of Industrial Research, Washington, D. C., in a recent paper. Prior figures on this subject are in general confirmed, but somewhat higher percentages of light reflection are shown. An interesting hemispherical integrating photometer chamber was used. The final values were based on a comparison with a block of white magnesium carbonate, the reflecting value of this being assumed at 88% from the figure found by earlier experimenters. A dark-colored linseed oil gave a coefficient only 6% less in reflecting value than a very light-colored flat varnish (61% against 67%). Gloss and flat varnishes gave the same coefficient, in contradiction of ordinary impressions. The effect of lampblack admixture was found to be very powerful in suppressing light reflection; a white pigment, which by itself (in flat varnish) gave 66% reflection, dropped to 44 when its color was changed to a light gray by lampblack, and to 27% when the color was made gray. Among colored paints the light cream, light pink, light yellow, light blue and light buff gave reflections over 50%, ranging from 66 down to 52 in the order named. Light green and light terra cotta showed percentages between 40 and 50, light and medium terra cotta being close to 40%; then downward the blues, greens and reds caused very rapid drop in the reflecting power, bright blue, green or red giving coefficients between 11 and 14%. The importance of these figures with relation to interior finish is obvious. Track experiments made by measuring the heat absorption of various pigments and paints were in general agreement with the photometer tests.

Crossties Are Branded after inspection by Baltimore & Ohio R.R. inspectors with a hammer having changeable heads, so that the brand will indicate the class and grade of the tie. This precaution is to prevent the ties purchased for treatment from being confused with white-oak or other nontreatment

FOR NON-TREATMENT TIES			FOR TREATMENT TIES		
KIND OF WOOD	CROSS TIES		KIND OF WOOD	CROSS TIES	
	BRAND	GRADE		BRAND	GRADE
White Oak Burr Oak Post Oak Rock Oak Chestnut Oak Cherry Mulberry Black Walnut Locust (except Honey Locust)	B&O 31 CLASS A	Grade 1 Grade 2 Grade 3	Red Oak Black Oak Scarlet Oak Pin Oak Water Oak Shingle Oak Laurel Oak Beech Maple (Hard or Sugar) Elm (White or Rock) Honey Locust	B&O 31 CLASS C	Grade 1 Grade 2
Chestnut	B&O 31 CLASS B	Grade 1 Grade 2	Maple (Silver, Soft or White) Swamp Maple (Red or Soft) Walnut (White) or Butternut Gum (Black or Sour) Birch (Red, Sweet or Black)	B&O 31 CLASS D	Grade 1 Grade 2
Heart Leaf Pine	B&O 31	Grade 1 Grade 2	Hemlock Pine (Short-Leaf or Loblolly)	B&O 31 CLASS E	Grade 1 Grade 2

BRANDS FOR CROSSTIES OF BALTIMORE & OHIO R.R.

ties and put into tracks before being treated, and to prevent the nontreatment ties from being shipped to treating plants. As the sketch shows, the brands for treatment ties are made of straight lines, and for nontreatment ties of curved lines. A tie bearing only the brand is a Grade 1 tie; accompanied by the figure 2, it indicates a grade 2 tie. Switch ties, bridge ties and piling are branded the same as grade 1 crossties—"Wood-Preserving."

The Wire Drag has revolutionized hydrographic surveying, says the annual report of the Coast and Geodetic Survey. It has long been realized that soundings with the leadline, no matter how carefully and closely spaced, were not infallible, and that submerged rocks and ledges were often missed, as has been demonstrated by numerous wrecks and frequent damage due to striking unknown rocks in surveyed waters; but with the development of wire-drag hydrography, these submerged dangers have been discovered and charted.

Editorials

Canadian Court Upholds Rights of Contractor

A notable suit was decided by the Superior Court of Montreal, Canada, on Jan. 17, in which was involved the right of a contractor to square dealing and prompt payment of monthly estimates. According to the evidence in the suit, Geo. W. T. Nicholson, a Montreal contractor, at the end of 1909 took a contract to build a power plant for the Canadian Light and Power Co. Under the agreement the contractor was to receive monthly payments on certificate by the company's engineer and final payment within 30 days after completion and acceptance of the work.

When the work was partly completed, one of the officers of the company conceived the idea of saving some money by inducing the contractor to consent to a change in the terms of the contract regarding the measurement of the material. This official knew that the contractor was hard up for money and that the payday for his men was four days overdue. The company itself was behind in the payment of its monthly estimate, then due. Taking advantage of this knowledge, the official induced the contractor to sign a letter agreeing to a change in the method of measurement, threatening that otherwise the company would further withhold payment of the monthly estimate. The engineers of the company, when the letter was shown them, protested that such a change in the terms of payment was unfair to the contractor.

It was further established to the satisfaction of the court that by the terms of an agreement made between the company and its engineers at a later date, the engineers became mere servants of the company and not independent certifying engineers. Under instructions from the company the engineers refused to sign a final certificate on the completion of the work, and the contractor was thrown into bankruptcy.

The judge said in his decision, "The engineer was unable to preserve an attitude of judicial independence between the parties, and this released the contractor from all conditions in his contract with the company by which he had submitted to have his rights determined by the engineer." The facts in the case were established not only by the evidence of the plaintiff, but by the engineers themselves. Under these circumstances the court gave a sweeping decision in favor of the contractor, pointing out particularly that the agreement extorted from the contractor to consent to a change of measurement was an agreement obtained by "coercion, violence and fear and was therefore null and void."

It is by no means an unprecedented procedure, unfortunately, for those who consider themselves shrewd business men to attempt to take one advantage or another of a contractor by withholding payments at the time they are due. It is of interest to have established by the courts, therefore, the fact that concessions obtained in such a manner will not be sustained by the law.

Should the Civil Engineers' Headquarters Be Moved?

The members of the American Society of Civil Engineers have received from the society's Board of Direction a statement of the proposal to remove the society's headquarters in New York City from the building now owned by the society on West 57th St. to the Engineering Societies' Building on 39th St. near 5th Ave. The general terms of the proposition on which the members are to vote by letter ballot were explained in our issue of Feb. 3. There are a number of matters in connection with the proposal which should be further explained in order that the members may be able to vote intelligently.

There are several aspects from which this proposed change in the society's headquarters may be viewed. The first of these is the business aspect. Admittedly, this is not the most important consideration in connection with the proposition, yet it deserves attention. The funds that the society has accumulated have been contributed from the earnings of thousands of hard-working engineers and should be carefully safeguarded. The first question to determine, therefore, is the comparative safety of these funds invested in the society's present house on West 57th St. and invested in the Engineering Societies' Building.

The present house of the society was built 20 years ago. At that time the part of West 57th St. where the society's house is located was a high-class residence district, and properties were increasing in value. The society has invested $185,000 of its funds in the land on which the building stands and $175,000 in the building itself. According to the recent appraisal made by real-estate experts employed by the Board of Direction the land has increased in value by about $100,000, but the building is appraised at only $35,000.

This loss of value is due, not to physical deterioration of the structure, but to a radical change in the character of the neighborhood since the building was erected. The house stands only a few doors from that part of upper Broadway which has now been entirely given over to the automobile trade. West 57th St. has become a favorite thoroughfare for motor cars. On one side of the society's house stands a high building devoted entirely to the motor-car business, with a garage close to the house. On the other side stands a church which has been abandoned by its congregation and sold, probably to make way for some business structure.

Twenty years ago, or even eight years ago, when the society built an addition to its present house, it seemed likely that the building, at any time when the society should deem best to make a change, could be sold at a fair figure for use as a club house. There is no such market for it now. If the society abandoned it, it would have to be sold for what it would bring for use as a restaurant or dance hall for those who frequent the automobile district.

The society is fortunate in that the increased value of the land for building purposes at present would partly offset the depreciation on the value of its building, in case the society should sell the property. It is apparent that it would be an unwise investment for the society to spend more money on its present house in the way of additions or alterations to meet the need for increased space. Structural values in this section, from all present indications, are much more likely to decrease—as has happened in so many other once fashionable sections of New York City—than to increase.

Turning now to the alternative—the purchase of an interest by the society in the Engineering Societies' Building on 39th St.—the situation here may be very briefly summed up as follows: The building, with the land on which it stands and the accumulated investment in the reserve fund of the societies owning it, represents an outlay of nearly $2,000,000. It is centrally located in the heart of the uptown hotel, club and theater district, where land has been steadily rising in value in the dozen years since the building was erected and is likely to have a further increase. The three other national societies that own the building, free and clear of all incumbrance, offer to admit the American Society of Civil Engineers to joint ownership in the building for the sum of $225,000 to $250,000, or for about the same outlay that the society would have made had it joined in the enterprise with the three other societies 12 years ago.

At that time the plan for a building for the joint use and occupancy of the national engineering societies was admittedly an experiment. Many were honestly doubtful whether it could be made permanently successful. The national societies of mechanical, mining and electrical engineers agreed to undertake the experiment at the same time that the Society of Civil Engineers voted against it. The experience of 12 years has proved the experiment to be a success from the financial as well as from every other point of view. These three societies now offer to admit the American Society of Civil Engineers to an equal ownership in this building—or in business terms, they offer to sell a quarter interest in a property worth in the neighborhood of $2,000,000 for a sum varying from $225,000 to $250,000, according to the plans which the civil engineers may decide to adopt.

It will be evident from the foregoing review of the financial status of the proposition that, if the American Society of Civil Engineers can sell its present house at the appraised valuation, it can pay the cost of its quarter interest in the Engineering Societies' Building and have a balance of $115,000 to $140,000 left in its treasury either for investment as a reserve fund or for any other use which the society chooses.

It should be mentioned, from the business side also, that the society will effect a considerable saving in the annual outlay for maintaining its New York headquarters—probably some $2,000 to $5,000—by removing to the Engineering Societies' Building. But as was previously remarked, the financial aspect is not by any means the most important for the society to consider. More important, without doubt, is the question as to the relative advantages of the new location for the society's headquarters as compared with the old. The headquarters of the society is, for one thing, a set of offices for the society's secretary and his staff of employees. So far as these offices are concerned, either location is satisfactory. So far as there is an advantage, it lies with the Engineering Societies' Building, by reason of its more convenient location to the new post-office building and the great uptown publishing center that is growing up in the post-office district. The space to be occupied by the society in the Engineering Building, furthermore, is on upper floors, while a large part of the space in the house on 57th St. now used for storage and various work in connection with publications is in the basement of the building.

It may be explained here that the space which the society can command in the Engineering Societies' Building will very much exceed in area the floor space in the society's present house, excluding that contained in the auditorium, which is of course proper, since in the occupancy of the Engineering Societies' Building the civil engineers would share the use of the auditoriums in the building in common with the other societies.

The headquarters of the American Society of Civil Engineers in New York City, however, ought to be not merely a set of general offices for employees, but a headquarters to which the members resident in New York City and vicinity and those who come to the city for business or pleasure will habitually resort. There is no reason why the society should not afford to its members at its headquarters in the Engineering Societies' Building some of the conveniences and attractions of a social club.

To effect this in the present house of the society has always been difficult. The building is not well arranged for this purpose and is further handicapped by its inconvenient location, especially for members out of the city who are living at hotels during their stay. The Engineering Societies' Building, on the other hand, can be reached in five to eight minutes from the Grand Central Station, the Pennsylvania Terminal, the subway and the Hudson tube. Convenience of access is a most important factor in encouraging and bringing about the use of the headquarters by the members, and unless a headquarters is resorted to by the members, no one will care to go there.

It is worth while to emphasize this point, because to the members located at a distance from New York it may appear as if the proposal before the membership is to move the society's headquarters from its own private club house to an office building. It should be clearly understood, therefore, that the new headquarters may be made more attractive as a place of resort than the old.

Those familiar with the clubs in any of the larger cities are aware that many of the social clubs which are most prosperous and successful and have the most attractive headquarters are located on the upper floors of high buildings. There is no reason whatever, therefore, why if the civil engineers decide to remove to the Engineering Societies' Building, the space they occupy there may not be so arranged and furnished as to provide not merely the office space required for the society's working staff, but spacious accommodations for those members who wish to use the society's headquarters as the rooms of engineers' clubs in the smaller cities are used.

There is even greater reason for this in the American Society of Civil Engineers than in the other national societies, since the members resident within 50 mi. of New York pay higher annual dues because of the privileges they are supposed to enjoy in the use of the society's headquarters. Such use, moreover, involves no disadvantage to a member residing at a distance. On the contrary, it is of advantage to him, whenever he may come to New

York, to be able to find at the society's headquarters a number of fellow members ready to give him a cordial welcome and to be able to use the society's rooms for correspondence, business appointments, etc.

Only a word need be said concerning the other facilities that the American Society of Civil Engineers would enjoy through its occupancy of the Engineering Societies' Building. The main auditorium in this building, which has a seating capacity for an audience of over 1,000, is one of the finest auditoriums in New York City. It will be possible to accommodate therein every member of the society attending the annual meeting and to enable him to hear what is going on—something wholly impossible of accomplishment in the auditorium in the present Civil Engineers' house, because of its limited capacity and poor acoustic properties. In addition, the society would share with the other societies the use of the smaller auditoriums in the building and also the rooms arranged for large receptions, luncheons, etc., with kitchen and service accommodations, which occupy the entire fifth floor of the building.

One of the most attractive and important features of the proposition is the plan to unite the library of the American Society of Civil Engineers with the libraries of the other three great national societies, already consolidated, forming altogether a library of nearly 150,000 volumes and carried on as a free reference library for the use of any member of the engineering profession. By searches made by an expert staff, moreover, the facilities of the library are made available to engineers residing at a distance. It would of course be possible for the civil engineers in removing to the building to retain, if they chose, their own library and carry it on separately from the other. There would be every advantage to the members, however, in effecting the consolidation and taking advantage of the admirable system of cataloging and reference searches already worked out by the staff of the United Engineering Library.

Twelve years ago, when the offer was originally made to the American Society of Civil Engineers to join with the other national societies in building and occupying the Engineering Societies' Building, the offer was rejected when put to a vote. Reference to the discussion that took place on the proposition at that time will show that the defeat was due to misunderstanding. The reasons which were given then for the society's not joining in the enterprise have no force at the present day. It was, for example a generally held opinion a dozen years ago that the proposition to have the four societies join in erecting and occupying the building was merely an entering wedge for some movement to consolidate the societies. The experience of a dozen years, during which the mining, mechanical and electrical engineers have occupied the Engineering Societies' Building, has demonstrated that there is no interference whatever of one society in another society's affairs, nor has there been the slightest movement toward consolidation. There has been, however, an increasing amount of coöperation between the societies through their governing bodies in matters affecting the general welfare of the profession. In these coöperative movements the American Society of Civil Engineers has joined.

The testimony of many prominent members of the society who voted against the plan to coöperate with the other societies in building and occupying the great engineering headquarters in New York City a dozen years ago is that the refusal at that time was an unfortunate mistake. This mistake there is now an opportunity to rectify. The Engineering Societies' Building has become, as those who planned it hoped, a great headquarters for engineering-society activities in New York City. It is occupied not only by the three national societies previously referred to, but contains the offices of a number of other national and local engineering and scientific societies, which share in the use of the auditorium, library and other facilities that the building offers. This great headquarters has been made use of when international engineering congresses have visited New York, and it is the center from which have started many movements for the benefit of the engineering profession as a whole.

Members of the American Society of Civil Engineers are constantly coöperating with mining engineers, mechanical engineers and electrical engineers in their professional work. The present proposition is that the society as a whole should coöperate with the societies representing other branches of the profession in the ownership and occupancy of a great engineering headquarters whose success is established beyond a doubt. It can do this under conditions that safeguard the society's financial interests, effect a saving in its annual expenses, provide facilities greatly superior to those which it now has, and that will aid the society to render greater service to its members and to the profession.

Defense of Suits on Patents in Reinforced Concrete

To most engineers engaged in reinforced-concrete construction it seems exceedingly strange that some of the patents on reinforced-concrete construction should ever have been issued by the Patent Office and stranger still that these patents should have been upheld by the courts. The same thing is true of a number of other patents that interfere with the free work of engineers in design and construction, such as some of the patents on sewage disposal and on road construction.

The position of engineers with regard to the class of patents referred to is that the patents are not on a real invention, but on a particular way of doing something; and they believe further that the state of the art when the patent was issued was such that the patent should be declared void by the courts for lack of novelty.

So far as the Patent Office is concerned, it may be explained that the examiners generally confine themselves to the question whether anticipations of the construction described by an applicant can be found in existing patent records. The question whether the alleged improvement involves invention or merely mechanical skill, the examiners generally leave to the courts to determine.

In studying some of the recent patent decisions where patents of doubtful validity have been sustained one is forced to the conclusion that the reason why the courts have decided in favor of the patentee is the weak defense presented by the alleged infringers.

The defense of suits of this sort has in some cases been intrusted to ordinary attorneys, with no especial experience in patent litigation and ignorant of the proper methods of procedure to establish their case. These attorneys have picked up any engineer they might happen to know and attempted to qualify him as an expert in the branch to which the patent relates. It needs only a

study of the court decisions upholding some of these patents to perceive that the defense failed to present important evidence as to the state of the art at the time the patent was issued, or at least to present it in such a way as to carry conviction to the mind of the judge.

Unfortunately for those who have to defend suits for patent infringement, it is customary in the Federal courts, when a patent has been sustained in one circuit, to make the decision in this first case controlling, if suits for infringement are brought in any other circuit. The defense in an infringement suit, therefore, labors under a serious handicap where the patent in suit has been supported in previous decisions, even though the patentee may have won his case only because the opposing side was weak. The decision of Judge Anderson in the Bone case, however, reviewed in *Engineering News*, Feb. 10, 1916, shows that, where a clear and strong defense is presented to a judge, the precedent set by a previous decision may be overruled.

The engineering profession has no quarrel with patents on real inventions, especially where the patent is made use of as the foundation for a business. It is broadly recognized that the rewards offered by the patent system are not merely to the inventor who conceives a new idea. The monopoly which the patent system grants is justified in order to induce capital to embark on the manufacture and introduction of the new invention and to educate the public to the advantages of its use. Neither the engineering profession nor the general public opposes patent monopolies of this class; but engineers do most strenuously oppose claims to a monopoly because some man who sees fit to describe in the patent records a plan to build a piece of work in a certain way claims on the strength of that record the right to demand tribute from everyone who thereafter, for the space of 17 years, shall build work in the same way.

It is only too evident that in sustaining a number of patents of this class the courts are proceeding in a vicious circle in their decisions. In order to show that invention exists in some of the reinforced-concrete patents the judges are quoting previous decisions supporting some of the patents on road construction that are generally condemned by the engineering profession.

We cannot too strongly urge upon the authorities of cities, counties or corporations having patent suits of this class to defend that they spare no pains in obtaining the most eminent counsel and patent experts who thoroughly understand their business and can go to the bottom of the case. If a suit is handled in that way, there need be little fear of the result. A good illustration is the iniquitous Selden patent, which was held as a club over the entire automobile industry for a number of years until the importance of the case caused the most eminent counsel to be retained and the patent defeated.

Letters to the Editor

Relations Between Assistants and Chief Engineers

Sir—I have followed closely the discussion in your very interesting columns on the subject of the coöperative system of civil-engineering training and approve especially the paper by Professor Stringfellow, in your issue of Jan. 13, page 63. There is one phase of the question of education by experience which I desire to bring to the notice of engineers.

I recall two young fellows who at different times and places entered the field party in which I was working and who wanted to know the "why and wherefore" of all that was being done. Fortunately for them, they were informed by their chiefs exactly what the aim was. The result was that these men took up their duties with zeal and advanced the work prodigiously. They applied their own brain power and skill to their work, and at the present time both are high in the profession.

I also recall how I was once engaged on railroad location under an impatient and inconsiderate man, a most profane and irritable speaker, who seemingly had no time to explain even to me, who was one of his principal assistants, what his movements were aimed toward. One day I was wholly lost from him and his followers, with a mountain and a river between us. I had a level with me, but had no idea what I was taking levels for. The chief engineer of the road was with him when we finally ran across each other, and in the din that followed I am sure I had the sympathy of the "big chief." No wonder I sometimes envied the pigs along the roadside for their moments of peace and contentment, for night and day we had no cessation of pain in our hearts. In an exchange of confidences one of the best fellows in the party told me that all the week he waited for Sunday and was blue all day Sunday thinking of Monday. P. G. MELBOURNE.

Hyattsville, Md., Jan. 26, 1916.

Designers Must Provide for Telephone Conduits

Sir—In the issue of *Engineering News* for Dec. 23, 1915, p. 1236, an article entitled "Outlet Boxes for Electrical Conduits in Concrete Buildings" called attention to the fact that proper attention is seldom given to the placing of electrical conduits and outlet boxes in concrete floors. I wish first to indorse this article, which holds architects and engineers responsible for the omission of proper detail in regard to type and location of conduits and the resultant tendency of the contractor to sacrifice either the adequacy of the conduits or the concrete reinforcement for the accommodation of both. I desire also to enter a further plea with special regard to telephone conduits and outlets.

Telephone service has undergone the same evolution as did electric-light service—from luxury to convenience and from convenience to necessity. The last step in this evolution, however, has been made much more recently in telephone service, and this may account for the apparent neglect of architects and engineers to incorporate in their

building plans and specifications provisions for an adequate and flexible system of conduits and outlet boxes for the accommodation of telephone cables and service wires. This omission, particularly in fireproof tile and concrete buildings, has been bringing the designer face to face with the problem of concealing the telephone wires after the completion of the building, which, if considered in advance and definitely incorporated in the building specifications, would have been comparatively simple.

In the case of a recently completed notable building the question of conduits for telephone service was not considered until after all contracts had been let and the foundation started. Upon the insistence of the telephone company the matter was given consideration, the requirements specified and the work of installing turned over to the contractor as an "extra," without definite locations for the conduits being assigned by the architects. Among the requirements was specified a 3-in. conduit in the basement floor, from the outer wall to the bottom of a column and up the column to the location of a switchboard. The contractor, without definite instructions, laid the conduit in the concrete floor with so many bends to avoid electric-light conduits, gas and water pipes and reinforcements that it was useless. He further waited for the construction of the column to install that part of the conduit and found the space occupied by other pipes and reinforcements which the designer, had he given the matter proper forethought, could have foretold. The walls being completed, it was then too late to choose an alternative location, and it became necessary to place the telephone cables in an exposed pipe crossing the basement ceiling. As the basement was to be used as a restaurant, this method was not desirable, and its adoption could have been prevented had the necessity been considered in the engineer's design.

I quote the above case, which is only one of a great many, in order to bring out the importance and the benefit alike to owner, designer, tenant and telephone company of giving the telephone conduits the attention which they deserve. An office building without telephone service is at the present time a place to be avoided by good tenants, and it is nearly as undesirable if the service is provided by running exposed cables through the halls, toilet rooms or other public places and fastening the wires on the outside of moldings, baseboards, doors, windows, etc.

R. D. GRAHAM,
District Engineer, New York Telephone Co.

Buffalo, N. Y., Jan. 15, 1916.

Oregon Water-Service Standards

Sir—After reading in your issue of Nov. 4, 1915, p. 885, the abstract of the rules of the Illinois Utilities Commission relating to standards of water service, I call to your attention Rule 28 as promulgated by the Oregon commission, for in speaking of the Illinois rules you state, "They do go beyond the Oregon rules, however, in the matter of interruptions to service."

During the winter of a year ago the largest utility supplying water under the jurisdiction of the Oregon commission did not maintain sufficient pressure at the end of its services to supply adequately each customer connected, with the result that service was interrupted for as much as a week in the higher levels of the city in question. Upon being given opportunity to show cause why the commission should not cite the failure to the proper legal officers for the exaction of the penalty contemplated by law, the officers of the utility agreed to refund to the injured customers a *pro rata* part of the monthly bill, the amount varying with the approximate time the customer was deprived of water. As this offer was satisfactory to the state and municipal officers, no further action was taken, it being considered that the utility had been subjected to a rather heavy penalty, which had been distributed among those who had suffered from the failure of the utility. It would appear that this concrete instance shows that, while the Oregon rules do not in so many words mention interruptions to service they are broad enough in their workings to cover interruptions to service.

E. W. MORELAND,
Engineer, Public Service Commission of Oregon.

Salem, Ore., Jan. 22, 1916.

[The Rule 28 cited by Mr. Moreland states: "Each water utility shall maintain sufficient pressure at the end of its services to supply adequately each customer connected, except customers who have specifically agreed to permit interruptions of service.—Editor.]

Granular Structure in Rivets

Sir—The following refers to your editorial on the failure of the Spokane bridge: In 1903 or 1904 a pin-connected bridge was being taken down on one of the branch lines of the Canadian Pacific Ry., because it was too light for the traffic, having been erected some 20 years before. As on other old bridges that were taken down, the men started to cut out the rivets with an ordinary cold-set, but found that they could do better work with a side-set, as used to cut out modern steel rivets. The heads of the old rivets flew off in exactly the same manner as those of the modern steel rivets.

The bridge men commented on this fact. While I admitted the difference in the cutting and the appearance of the break, I maintained that the rivets were of iron, which led to so much discussion that the bridge department asked for samples for a chemical analysis. These samples were broken from angle bars of about ½ in. thickness with a small blacksmith hammer that had been used for testing rivets, and only a few blows were required to break off a corner. In no case was it necessary to bend the metal through more than 90°. It broke off in exactly the same manner as zinc and showed the same granulated structure. The chemical analysis proved that the material was iron.

In the automobile trade it is well known that axles, drive shafts and crankshafts break under certain conditions, and the cause is ascribed to "crystallization" due to a knock in the engine or to imperfect lubrication.

CHARLES D. NORTON.

Sudbury, Ont., Jan. 22, 1916.

Water-Power Development in the West is hindered more by lack of a market for the power when developed than by the existing state and Federal restrictions according to the annual report of the chief of the Forest Service. The report says: "With rare and minor exceptions, existing power developments in the Western States are far in excess of market demands. The Forest Service is being constantly importuned to extend periods of construction on power permits on the plea that there would be no market available for the power if the project were developed."

Failure of the Lower Otay Dam

By Roy A. Silent*

SYNOPSIS—An unprecedented rainfall gave a runoff that overtopped this poorly designed and built rock-fill dam, dependent on a riveted steel-plate diaphragm for water tightness. In a few minutes the downstream portion of the rock fill melted away, then the steel diaphragm was torn from the top downward and the remainder of the dam opened like a pair of gates. A "wall of water" rushed 10 mi. down the valley in 48 min., causing the loss of at least 14 lives and property damage of $250,000.

The Lower Otay dam of the San Diego water-supply was completed in August, 1897, by the Southern California Mountain Water Co. and was subsequently acquired by the city. It was designed by, and constructed under the direction of, E. S. Babcock, at that time president of the company. It was located at the head of a rocky gorge 2 mi. in length. Above the dam the valley spreads out to a width of approximately half a mile and covers an area, when filled to the bottom of the spillway, of 859 acres. The bedrock at the dam site is a porphyry formation that is shattered and seamy.

It was originally planned to build the dam of masonry, and foundations were laid reaching a depth of 38 ft. below the zero contour and carried up to a height of 12 ft., where the top length was 85 ft. When the work had proceeded thus far, it was decided to change to a rock-fill dam with a steel core, or diaphragm, to render it water-tight.

The completed dam had a length of 565 ft. and a height of 130 ft., the crest being at a mean elevation of 482 ft. above sea level. It was originally planned to build the two faces of the dam on a slope of 2 to 1. This plan was changed, and the dam as constructed had face slopes of 1 to 1,[1] the top width being approximately 12 ft. Materials for the dam were taken from a quarry on the west side of the cañon, about 100 ft. below the dam. The major portion of the fill was loosened by the explosion of 12,000 lb. of powder. A second blast supplied sufficient rock to complete the dam. This material was placed by means of a Lidgerwood cableway.

Riveted Sheet-Steel Plate for Watertightness

In the construction of the diaphragm an angle iron was anchored to the top of the masonry foundation by 1-in. bolts, the vertical member being punched with ⅝-in. rivet holes 3 in. c. to c., to which were attached the bottom of the plates forming the steel core. The plates were 5 ft. wide, 17½ ft. long and the three bottom courses 0.33 in. thick. Above 28 ft. high the plates were ¼ in. thick, and above 50 ft. they were 8 ft. wide and 20 ft. long. The steel core was carried to an elevation of 132 ft. above the zero contour. The plates were hot riveted. A single row of ⅝-in. rivets spaced 3 in. c. to c. were used.

The side of the diaphragm next the water was coated with hot asphalt and covered with a layer of burlap. A harder grade of asphalt was subsequently applied over the burlap, and the whole was then covered by a rubble concrete wall 2 ft. thick, with the steel plate in the center. The form boards consisted of 1x6-in. boards laid horizontally and backed by 2x6-in. posts. These forms were left in position. Owing to uneven expansion the steel core was not uniformly in the center of the concrete core wall, but it is understood that in all cases there was at least 6 in. of concrete between the steel and the outside of the wall. The core wall was carried into the side walls in a trench and anchored with bolts leaded into the bank.

The material forming the fill was allowed to lie as it was dumped into place. The amount of fine material in the fill, as shown by the examination after the failure, was much greater than had been ordinarily supposed. This fill was carried to a height of 133 ft. above the zero contour, or 3 ft. above the top of the core wall. Subsequent settling lowered this to an elevation of 132 ft., or 2 ft. above the top of the steel core wall, its position at the time of the failure. No effort was made to protect the lower face of the fill. On the water side a boom of logs chained together was used as a protection

PORTION OF STEEL CORE IN CANYON, HALF MILE BELOW DAMSITE

CANYON IMMEDIATELY BELOW DAM, SHOWING STRIPPING ACTION OF WATER

*Engineering offices of J. B. Lippincott, Los Angeles, Calif.

[1]A letter from Allen Hazen, dated San Francisco, Feb. 9, states that after study of his photographs of Oct. 27, 1915 (see "Engineering News," Feb. 3, 1916), he thinks a slope of 1¼ to 1 is more nearly correct than 1 to 1.—Editor.

against wave action. (See Fig. 5, p. 238, *Engineering News* of Feb. 3.)

The spillway, built of concrete, is located on the east bank and has a width of 37.9 ft. at the bottom and 41.5 ft. at the top. The depth is 8 ft. It has a uniform slope of 0.00365. The capacity when running full is approximately 2,400 sec.-ft., after allowing for entry and velocity heads. The reservoir has a tributary drainage area of 139 sq.mi, and there are published records of flood discharges of 100 sec.-ft. per sq.mi. in the adjoining Sweetwater drainage basin.

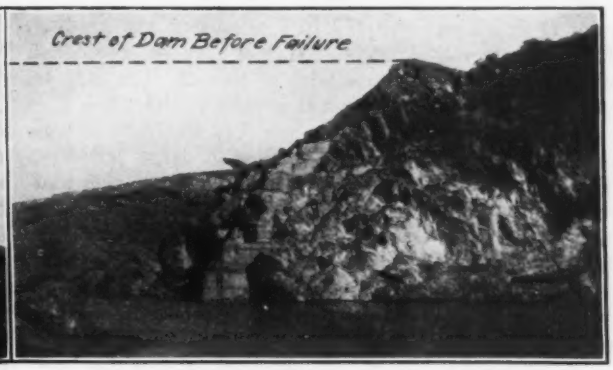
There is no blowoff provision from the reservoir, except through the outlet tunnel, which is 48 ft. above the zero contour. This tunnel is 1,150 ft. long, driven through a hardpan and cemented-gravel material. At the lower end of the tunnel there is a Y-connection, at which there is a 48-in. blowoff gate valve. The estimated maximum discharge of this blowoff, with a head of water to the bottom of the spillway, is approximately 400 sec.-ft. Until the recent flood the water had never been higher than 15 ft. below the bottom of the spillway. A small leak in the dam discharged approximately 25 miner's inches. This water was pumped back to the reservoir by a pump located at the foot of the dam.

The storm that caused the failure of this dam was unprecedented in the history of San Diego. The mean total annual rainfall for a 65-yr. period is 9.57 in. at San Diego; the mean for the same period for the month of January is 1.84 in. The total rainfall to date this season is 10.89 in. From Jan. 15 to 20 there was registered at the dam 5.60 in. of rain. No particular damage to the countryside resulted from this rain. From Jan. 20 to 24 inclusive there was no rain. On Jan. 25, 26 and 27 there was 3.54 in. of rainfall at the dam. On Jan. 27 the United States Weather Bureau gage at San Diego registered 2.19 in. This rain did great damage, destroying practically all the bridges in the county, rendering many families homeless and flooding and inundating considerable areas, in addition to the loss of life and destruction of property caused by the failure of the dam.

Prior to Jan. 15 the water surface in the Otay reservoir was 96.5 ft. above zero contour. From Jan. 16 to 21 at 7 a.m. it had risen 11.8 ft. to a height of 122 ft. 8 in. At this time, water began to run over the spillway. From Jan. 21 on, the level continued to rise in spite of the discharge through the spillway. On the morning of Jan. 27 the reservoir was at 124 ft. 9 in., and the spillway was probably discharging in the neighborhood of 1,500 sec.-ft.

The rain on Jan. 27 was extremely heavy, and by noon the water had risen so high that Mr. Weuste, in charge at the dam, deemed it advisable to open the outlet gate. This failed to check the rise, and it was realized that the dam would probably be overtopped before evening.

WEST ABUTMENT, SHOWING REMAINS OF STEEL CORE WALL



EAST ABUTMENT, SHOWING REMAINS OF CORE WALL

Men were accordingly dispatched to warn residents in the valley to move to higher ground. Word to this effect was also sent out from the telephone exchange at National City. Most of the inhabitants took advantage of this warning.

At 4:45 p.m. the water had reached the top of the dam and had seeped through and filled the boxes that were sunk in the top to allow an examination of the steel core. Water began running down the lower face on the east side of the dam at approximately 4:50 p.m. About this time several spouts or small streams of water appeared on the lower face of the dam, in one instance loosening a large boulder which rolled down to the bottom. From this time on, the destruction was very rapid. The lower face of the fill quickly melted away, thus removing the support from the core wall. At 5:05 p.m. the tension was so great that the steel diaphragm tore from the top at the center, and the dam opened outward like a pair of gates. The released water rushed through and filled the cañon to a point approximately 20 ft. below the top of the dam. The draw-down area extended possibly 200 ft. behind the dam. It required 2½ hr. for the reservoir to empty.

A huge wall of water, variously described as from 6 to 20 ft. high, rushed down the valley, covering the distance from the damsite to Palm City, about 10 mi., in 48 min., carrying all before it. The total loss of life has amounted to 14 at the present writing (Feb. 8), but there are still several persons missing. The property damage is estimated at $250,000.

Examination of Damsite and Valley Below

A thorough examination of the damsite was made on Jan. 31 and Feb. 1. Practically all the fill was washed completely away. The steel core was deposited in varying-sized sections along the valley, a large part being found at Palm City, 10 mi. below the dam. The core wall had torn itself loose from both of the side walls, as shown in the accompanying photographs, the foundations remaining intact. An examination of the bottom was im-

possible, as water to a depth of 8 ft. was flowing through a constricted channel in the bottom of the cañon.

Three-quarters of a mile below where the dam had stood a piece of the diaphragm was observed, to which the angle iron forming the bottom of the steel plate was riveted, showing that the extreme bottom had been torn loose. On the west side behind the remaining core wall was a small part of the fill, composed of rock of small sizes, none of which was over 1½ ft. in diameter, and grading from that to coarse gravel. If this may be considered a fair sample of the remainder of the fill, it is easy to understand its melting away as rapidly as described.

The cañon below the dam, prior to the failure, was considerably restricted and filled with large boulders. The action of the water removed all the loose rock and thoroughly stripped to bedrock both sides of the cañon as high as the water reached, the line of demarcation being clearly defined. The stripping was done in a most thorough manner, no particle of soil remaining in any of the niches or crevasses. This area was heavily wooded with brush.

An interesting feature was observed in that for half a mile below the dam in practically every pocket or niche in the rock was to be found a rivet head. An examination of the remaining parts of the steel core showed it to be in a perfect state of preservation, no rust or corrosion being noticeable. The destruction of the plate had taken place for the most part along the riveted seams, though one or two cases in which the sheets had torn were observed.

The reservoir above the dam showed a deposit of silt to a depth of from 5 to 6 ft. in most places, through which the present flow of the river is cutting a channel. The amount of silt deposited cannot be taken as a fair average for reservoirs in this section of the country, as much of the water passing into the reservoir was carried by a conduit and was comparatively clear.

Ohio Engineers Discuss Roads

Roads were the dominating subject at the annual meeting of the Ohio Engineering Society, Feb. 9 to 11, 1916, at Columbus. County surveyors, who form a large part of the membership of the society, made up the bulk of the attendance. The welcoming address of W. O. Thompson, president of Ohio State University, early introduced the road question by referring to the absence of records of road-building methods and the lack of experimental knowledge of road endurance. He advocated a state road-testing laboratory.

That the society is in a period of active growth is due in part to the effect of the recent Cass highway law in bettering the compensation of county surveyors. The legislative committee of the society helped put this law into the statutes of the state, and one result of this action is a considerable increase of county surveyors in the membership. However, the society includes many private and corporation engineers. There is promise that the representation of this part of the profession will grow and that the program of next year's meeting will correspondingly cover engineering subjects other than roads.

By laying the brick road surfacing on the foundation concrete while the latter is still green and unset—that is, within a few minutes after placing and screeding the concrete—the town of Paris, Ill., last year made a sharp divergence from established brick-road building practice. M. B. Greenough, instructor Case School of Applied Science, Cleveland, Ohio, in describing the Paris procedure, put these roads in a class by themselves as "monolithic" brick pavements, while he used the term "semimonolithic" to describe brick pavements laid on a dry cement-and-sand cushion coat spread on top of a hardened concrete foundation.

"Monolithic" Brick Pavements

The essential tool used in the Paris construction is a double templet, or screed, which strikes off the foundation concrete and also spreads and evens a cement-and-sand intermediate layer, called the luting layer. The templet consists of a 6-in. I-beam transverse to the road as front edge, and a channel 2 or 3 ft. back of the I-beam as rear edge. The templet slides on top of steel side forms or temporary curbs; it is hauled forward by a drum on the concrete mixer. The space between the I-beam and the channel is filled with dry sand and cement. The channel is set so that its bottom is about $\frac{3}{16}$ in. higher than the bottom of the I-beam. When the templet is pulled forward, it screeds off the top of the concrete placed ahead of it and then covers the concrete with a thin layer of sand and cement.

This luting layer fills all irregularities in the surface of the concrete and forms a smooth bed for the brick. The bricks are laid close behind the templet. As the luting layer is on fresh concrete, it quickly absorbs enough water to form a stiff mortar, bedding the brick and cementing them down. Rolling with a light hand roller and grouting next day finish the pavement. The surface obtained is reported to be unusually even.

D. Moomaw, Cuyahoga County road engineer, advanced some original ideas in discussion. Aiming at real monolithic construction, he disapproves of the dry sand-and-cement course and holds that a well-mixed mortar should be used. The concrete base should have a deficiency rather than an excess of coarse aggregate, so that ramming will bring mortar to the surface to constitute the bonding course. He also disapproves of omitting the concrete edging. In Cuyahoga County the edging, made monolithic with the foundation, is cheaper per unit of pavement surface than the brick.

Concrete-Road Development in Lake County

During successive years concrete-road construction in Lake County has gone through a regular development. H. P. Cumings, county surveyor, Painesville, gave a detailed record of the work, with prices, and indicated several conclusions from experience with the finished pavements.

The most recent deduction is that reinforcement is the only means of preventing cracking. In several roads contiguous pieces of reinforced and unreinforced work showed cracking in most of the unreinforced blocks, the cracks stopping at reinforced blocks in all cases. Blocks of 33 ft. are the regular practice. Armored joints are preferred. Difficulties were experienced at times with poor sand in the concrete.

County and township duties in getting in shape the earth, gravel and macadam local roads were discussed in two strong addresses. F. M. Kennedy, of Washington, Ohio, spoke to the title "Coöperation the Keynote in the Expenditure of the Two-Mill Levy." Jesse Taylor, presi-

dent of the Ohio Good Roads Federation, spoke on "Maintenance and Repair." The main theme of both speakers was the need of systematic attention to the minor roads, unimproved and partly improved. The great extent of road improvement under the state-aid laws is apt to bring about neglect of the minor roads, to the disadvantage of the local population.

Mr. Taylor, referring to the likelihood that some county surveyors may neglect road-maintenance work in favor of work that yields special compensation, went so far as to forecast amendment of the Cass law by the next legislature in the direction of reducing the compensation of county surveyors.

Other papers on road subjects were: "Glutrin as a Binder," by C. J. Knisely; "The Penetration Method of Building Bituminous Roads," by H. B. Stone; "Road Legislation," by Senator Charles C. Cass; "The Ohio State Highway Department," by Clinton Cowen; and "Does a Material Salesman Ever Coerce the Public Officials or the Contractors?" by F. W. Patterson.

Questions in Flood Protection and Conservancy

A bold attack on the present method of handling flood protection in Ohio (under the conservancy law) was made by Prof. C. E. Sherman, dean of civil engineering, Ohio State University, Columbus. His address, entitled "Some Phases of Conservancy Engineering," followed the general lines of the elaborate monograph which he recently published, "The Ohio Water Problem," Ohio State University Bulletin, November, 1915. The speaker asserted that flood-protection work, planned for a half-century emergency, must also take care of the next half-century's needs as to rivers. Water-supply, power and transportation are chief among these needs, and the conservancy law as hitherto interpreted neglects them entirely. The scarcity of water-supply sources for the interior cities of the state is a problem even today, and the search for water becomes more difficult each year.

That water transportation will be very important in the future was discussed rather fully by the speaker. The basal point of this discussion was the statement that present transportation agencies have reached the limit of their possibilities in carrying low-grade freight and that water routes will allow cheaper movement of bulk freight.

A series of pictures was displayed to show the great efficiency of sod in preventing flood scour. Various experiences in Columbus during the great 1913 flood proved the protective value of sod. Even narrow strips acted as perfect protection to the soil below, although macadam roadways were completely washed out close alongside.

Several papers of general engineering interest were presented: E. G. Bradbury on the new Akron water system; G. H. Charls on "pure" iron ("Armco" metal); D. B. Luten on concrete arch bridges; J. M. Vance on bridge paints; W. A. Stinchcomb on the Cleveland viaducts; Prof. T. J. Smull on engineering failures; and C. L. Bushey on drainage legislation.

The meeting was held at the Ohio State University, as was that of last year. A dinner at the students' club house, the Ohio Union, was a feature of the gathering. The support of the university was recognized in the election of Prof. Clyde T. Morris as president of the society for the coming year. A. R. Taylor was elected vice-president. John Laylin, of Norwalk, was reëlected secretary and treasurer.

Minnesota Engineers Meet

A large and interested gathering of both local and out-of-town engineers marked the twenty-first annual meeting of the Minnesota Surveyors and Engineers' Society, held at St. Paul, Minn., Feb. 10 to 12. One session was held jointly with the Civil Engineers' Society of St. Paul, and one evening the state society met with the Minnesota section of the American Society of Mechanical Engineers to hear an address on the manufacture of portland cement by Geo. P. Dickmann, chief chemist of the Northwestern States Portland Cement Co.

Two special addresses were those on "The Relations Between the Architect and the Engineer," by W. C. Armstrong, chief engineer of the St. Paul Union Station Co., and "Public Duties of an Engineering Society," by F. H. Newell, head of the civil-engineering department of the University of Illinois. This latter address followed the annual dinner, in which the Engineers' Club of Minneapolis and the Engineers' Society of St. Paul participated.

Drainage and road construction were prominent topics. A paper on "Drainage Surveying," by J. E. Cole, county engineer, Morris, Minn., referred to the unsatisfactory method of assessing benefits for drainage where there are such large variations in benefits derived. In the discussion, stress was laid upon the fact that lawyers and judges have little or no understanding of the technical features of drainage work or surveys—a fact that accounts for many unsatisfactory decisions in regard to assessments. Prof. John T. Stewart, State Agricultural College, dealt with drainage engineering. A great amount of drainage work is being done, and there are immense possibilities; but a good part of the earlier work has been done without proper engineering investigation or supervision, and the unsatisfactory results have led to unfavorable opinions in the rural districts. It is for the engineer to educate the public mind in this direction as well as to carry out the strictly engineering work.

Papers on roads, by three engineers of the State Highway Commission, dealt with road work by contract and by county forces and gave the comparative cost of hauling by tractors and by teams. Two papers presented the special problems of streets in hilly towns. One related to sidewalks and curbs on steep streets and sidehill streets, and the other to the conditions at street intersections. Street sprinkling by city forces at Rochester, Minn., was described by J. C. Utton, city engineer. The work proved to be cheaper than by contract, and a notable result was that complaints practically ceased.

In relation to water-supply and sewerage work the Committee on Municipal Affairs pointed out that construction and maintenance of water-supply systems are often without proper engineering supervision, and that in many cases the installation of water filters is the result of enterprising salesmanship rather than scientific investigation of a sanitary problem. For wells it suggested also the advisability of making a watertight joint between the well casing and the drop pipe as a sanitary precaution, although this is rarely done. In the past, sanitation has been considered largely a matter for the medical profession; but the engineer is probably better qualified to deal with such problems, and the two professions might coöperate more in future, with great benefit to the public.

A resolution was adopted opposing the proposition of the Minnesota League of Municipalities to ask the legislature to authorize and make appropriations for an engineering staff of the University Extension Division to furnish advice to municipalities in regard to public utilities. This plan is considered unnecessary, since it would duplicate work already covered by the State Board of Health and the State Highway Commission.

The officers for 1916 are as follows: President, F. W. McKellip, city engineer, Baraboo, Wis.; vice-president, B. J. Reynolds, drainage engineer, Redwood Falls, Minn.; secretary and treasurer, W. F. Rosenwald, State Highway Commission, St. Paul, Minn.

Judge Anderson's Decision on the Bone Retaining Wall

In the case of Frank A. Bone against the Board of Commissioners of Marion County, Indiana, for the infringement of United States Patent No. 705,732 on a reinforced-concrete retaining wall, Judge A. B. Anderson, on Jan. 26, 1916, rendered an oral opinion dismissing the bill for want of equity. The Bone retaining-wall case was fully discussed in *Engineering News*, Feb. 10, 1916, p. 254. To complete the record, Judge Anderson's decision is reprinted in full herewith:

IN THE DISTRICT COURT OF THE UNITED STATES,
FOR THE DISTRICT OF INDIANA

Frank A. Bone
vs.
Board of Commissioners of Marion County, Indiana, et al. } No. 7293, In Equity

Now, when I started into the hearing of this case and it was stated to me that the Circuit Court of Appeals of the Sixth Circuit had upheld this patent and had found infringement, I thought that the defendant would have a very serious time in attempting to get this court to differ from that court. I believe that if the question were doubtful, this court ought, in the interest of the proper administration of justice and the protection of the rights on both sides, if possible, agree with the court which had passed upon it before. But it is perfectly evident to my mind that the very foundation of the decision of the Circuit Court of Appeals, as well as the foundation of the decision of the district court from which that case was appealed, was wrong; the very foundation of it was wrong. Gentlemen may go out from here with the absolute conviction that the court as constituted here did not understand this case; but I am very firmly convinced either that the matter was not fully presented to the district judge in Cleveland and that the record was not as fully made up in the Court of Appeals as it is here, or at least that they did not understand it—one or the other.

Now this man has set out here what his invention consists in. I notice that where a plaintiff has not a very clear ground to stand upon, it is pretty hard to get him to tell just what the invention consists of, and frequently I must go back to the patent to see what it means. Now it is stated here:

My invention relates to improvements in retaining walls for abutments of bridges, sea walls, banks of streams, embankments, cuts, dams, dry docks and such places as it is desired to retain earth or other matter permanently in place with its face at an angle nearer vertical than it would naturally repose when exposed to the action of the elements or gravity.

This is to what his invention relates:

The said invention consists principally of introducing into masonry of concrete, stone or brick a framework of steel or iron in such a way that the whole wall is so much strengthened thereby that the volume of the masonry may be greatly reduced, and yet the height, base and strength against overturning, bulging or settling will still be ample.

Then he says further:

The object (stability with reduced volume) is further accomplished by the peculiar shape of the cross-section of the wall allowable.

Of course, that is true. Anybody could see that. Any boy who worked with mud could see that if you made the top of a wall three feet and the bottom two feet thick, it would not be as strong as if the proportions were reversed. So a man cannot predicate invention upon the peculiar shape of the cross-section of the wall.

Now, this case went before Judge Day, and what did he decide? Unfortunately for these gentlemen, the reasons are put in writing, and I see the judge's name is signed to it.

The invention claimed relates to retaining walls or similar structures designed to retain earth or other matter in place with its face at an angle near vertical—

he means nearer vertical—

than it would naturally maintain as affected by the force of gravity and the action of the elements, and the invention consists in embedding in retaining walls of concrete, stone or brick a frame or skeleton of metal arranged in certain relations to the stresses which the wall is required to withstand.

Now, anybody who understands the reinforcement of concrete knows that from the very beginning of that art the metal was arranged in certain relations to the stresses that the wall was required to withstand. That ought to be so.

The object is to obtain ample resistance to breaking, bulging, overturning or settling with a smaller volume of masonry than would be required for the ordinary gravity wall of equal strength and stability.

The object of every wall builder is to get the required or desired degree of strength with less masonry.

The patent describes and illustrates a concrete wall consisting of a thin vertical wall having an extended heel and toe reinforced in the upright portion by upright metallic members at the back part of the wall, and in the heel by metallic members extending obliquely along the upper part and in the toe by metallic members extending transversely along the bottom. The reinforcing members are placed near the back face of the wall and heel and nearer the lower face of the toe. . . .

This wall described by the patent uses the weight of the retained material to retain itself; while in the gravity wall, which was old in the prior art, the resistance to overturning is the wall itself.

Then going on further:

Considering the claims of the patent, and the testimony, I am of the opinion that Bone, the patentee, was the first to reinforce the retaining wall or similar wall of concrete or masonry in such a manner that the weight of the retained material would be utilized to impart through the reinforcing members tensile resistance to the stern or vertical part of the wall, thereby fortifying this part of the wall against breaking strains.

And we now know in the light of the evidence in this case that Bone was not the first to reinforce the retaining wall in such manner that the weight of the retained material would be utilized to impart through the reinforcing members tensile resistance. He was not the first person to reinforce a retaining wall; he was not the first to conceive the idea of a reinforced retaining wall which was so shaped and constructed that the weight of the earth on the heel of the wall would withstand the pressure of the dirt or the earth on the wall. He was not the first to do it. If there is anything that is absolutely demonstrated by the evidence in this case, he was not the first to do what Judge Day says he was the first to do, and upon that he predicates his opinion. Now it may be that upon the record before Judge Day, Bone was the first person to do that. So far as the record in this case is concerned, the absolute converse of that proposition has been demonstrated.

In the decision of that case in the Circuit Court of Appeals for the Sixth Circuit the claims involved are the same as in this case, plus claim No. 2. There the claims were 1, 2, 3, 5, 16 and 17. Now, let us look at the decision:

In the present more or less familiar state of the reinforced-concrete art the impression is natural that there cannot be patentability in the structure of these claims; but the patent was issued upon an application filed in 1899, which was a renewal of an application in 1898, and Mr. Bone's idea is shown to have antedated his application.

How far it antedates it, there is not anything here to show.

We are thus carried back nearly 20 years. The record discloses nothing anticipating the substantial thought of the patent.

Now, what is the substantial thought of the patent?

The said invention consists principally of introducing into masonry of concrete, stone or brick a framework of steel or iron in such a way that the whole wall is so much strengthened thereby that the volume of the masonry may be greatly reduced, and yet the height, base and strength against overturning, bulging or settling will still be ample.

The record in this case shows a number of things to anticipate that substantial thought. The court goes on and evidently had in mind the distinction between a gravity wall and this wall:

Masonry or concrete retaining walls were deep and heavy, and maintained by gravity in their resistance against a horizontal stress. There was no occasion for reinforcement. Sustaining walls had been built of concrete with vertical reinforcement; but they were maintained against side strain by crossties or beams, without which they might tip over. If the prior art had shown a structure intended for a retaining wall and having a heel such that the weight of the earth thereon would tend to keep the wall erect, it might be difficult to find invention in merely adding the form of reinforcement most suitable to create the desired tensile strength; but we find no such earlier structures.

Now the evidence in this case shows a number of such earlier structures, and so the very foundation of this opinion

is taken away by the evidence in this case, assuming that the decision was based upon the record as it was there.

On the application for a rehearing, where the court declined to direct the court below to open the case to permit the defendant below to put in a certain German patent after deciding that there was no satisfactory excuse for not producing the proof in due time, the court went on and said:

While the new reference (if it passed the limits of mere suggestion or unsuccessful experiment) would be distinctly pertinent upon the issue of invention, and if properly proved in another case should receive careful consideration, it is not so demonstrative of error in the result already reached as to require its reception.

So the court did not have before it the evidence either on the petition for a rehearing or on the original hearing, that this court has on the state of the prior art.

There is shown here beyond any question whatever retaining walls, anticipations of retaining walls, publications and descriptions of them which are of the cantilever type. One where the vertical bar is held in a vertical position by the weight of the earth upon the horizontal part of it, or the heel of it held by the weight of the earth which is to be retained, and those various retaining walls of that kind, operating in that way, are shown to be reinforced in various ways. So far as the shapes are concerned, they use various diversified shapes that are shown by this patentee. Take one of these exhibits which has the counterfort form. Take this model, for example. There is foreshadowed the very idea of the slant up. The character of the top there is the same, or it may be carried to a place not so near the top, and if this is a correct representation of the patent, the model here discloses it in detail.

When we come to the Stowell and Cunningham device, I cannot see how that is not a complete anticipation of everything this man did except it be that his patent is to be limited to the particular form which he shows for his framework. There is a retaining wall of concrete, with a framework of steel or iron, introduced into the concrete in such a way that the whole wall is much strengthened, and so much strengthened that the amount of material is much reduced. There is the model. How could any court understand this art, and understand what the patentee claims, and understand the Stowell and Cunningham patent and find that it does not anticipate, is beyond my comprehension.

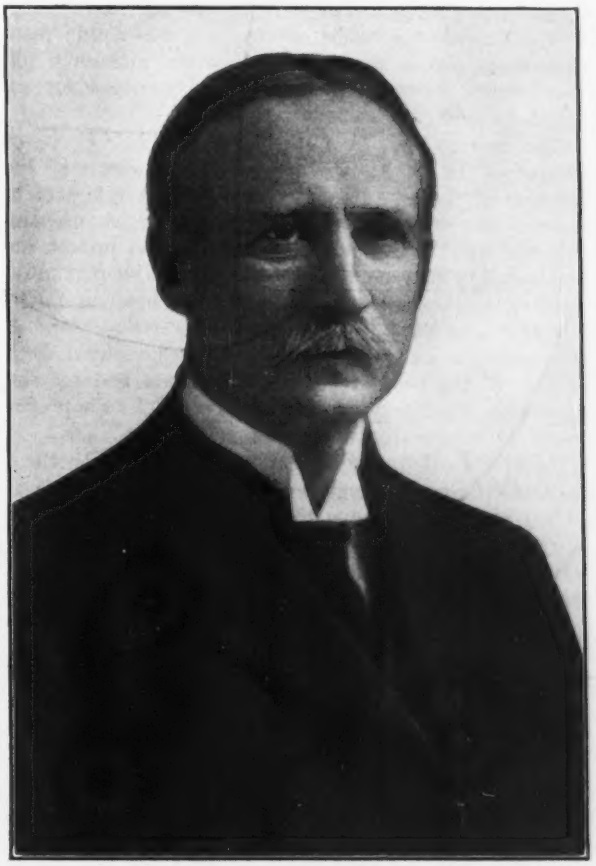
I assume that this Stowell and Cunningham patent was in some of these cases, but it is not necessary for me to hold that this patent is invalid in order to come to the conclusion, or reach the conclusion that I have to reach in this case. It may be valid, but if so, I do not think much can be said on that theory. If so, the only thing this man did was to devise a framework and embed it in concrete, and if you want to carry it forward, there is the method in which it should be embedded, in the sense that it was a framework put up first and the concrete poured in afterward. Now, I think it is going a long way to assert that what the defendants did is an infringement of this patent on either ground; and inasmuch as I am a mere examining magistrate and inasmuch as the defeated party usually thinks that the trial court knows nothing about it and that he will go to a court that does understand it, I will dismiss this bill for want of equity. The record will show the bill dismissed for want of equity.

New President of the Canadian Society of Civil Engineers

George Eric Duggan was born in Toronto, Canada, in 1862 and was educated at Upper Canada College, Toronto, and at the School of Practical Science, Toronto University. In 1884 he joined the Canadian Pacific Ry. and was assigned to location work on the mountain division. He remained with the railway until the end of 1885, before which time he had been assigned to the drawing office and placed in charge of the division of bridge erection and of a section of grading.

In January, 1886, he entered the drawing office of the Dominion Bridge Co.—of which thirty years later he became General Manager—becoming Chief Draftsman in 1889 and Chief Engineer in 1891, which position he held until the end of 1901. During this period the company erected a number of Canadian bridges, including the first Coteau bridge, the Grand Narrows and St. Mary's River bridges, the Inter-Provincial bridge at Ottawa, the swingbridge and the emergency dam at Sault Ste. Marie, Ont., as well as the first Canadian hydraulic lift-lock, on the Trent Canal, at Peterboro, a structure still cited as a model in its field.

He went to Sydney, N. S., in January, 1902, to become assistant to the president of the Dominion Iron and Steel Co. and of the Dominion Coal Co. A considerable amount of civil-engineering work was then being prosecuted by both companies, and Mr. Duggan was placed in charge of it. In 1903 he became Third Vice-President of both companies, and in 1905, when the companies separated, he was appointed Second Vice-President and General Manager of the Dominion Coal Co., remaining in that capacity until 1910. He was responsible for the engineering work of the Dominion Coal Co. and for the opening of a number of new mines, the construction of



GEORGE ERIC DUGGAN

docks and unloading plants and the extension and operation of the company's railway service.

In 1910 Mr. Duggan returned to the Dominion Bridge Co. as Chief Engineer, in which capacity he was responsible for the preparation of the design for the new Quebec Bridge, for which tenders were being prepared at the time he became Chief Engineer. In 1912 he was appointed Vice-President and General Manager of the Dominion Bridge Co. and Chief Engineer of the St. Lawrence Bridge Co., a company which formed to bid on the superstructure of the new Quebec Bridge and which was awarded that contract. He has continued actively since then in the great work of building this bridge.

News of the Engineering World

Military-Engineering Lectures Draw Big Crowds

The series of lectures on military engineering, started Feb. 14 in New York City under the auspices of a committee of the national societies of civil, mechanical, mining and electrical engineers, drew out a crowd that far exceeded the dreams of the promoters. The advance registration was so heavy that ticket admission was put on and a parallel session arranged. The main auditorium of the Engineering Societies' Building was filled; there were about 500 in the small auditorium, and some 700 were turned away. The lectures will continue for six Monday evenings.

The first lecture, by Capt. T. M. Robins, Corps of Engineers, U. S. A., was a general exposition of the function of engineer troops, with particular reference to services for which civilian engineers might prepare. Summed up, the duties of this force are to protect the line troops by equipment and works, to provide maximum comfort, to construct and operate transportation facilities, and—not the least—to engage in active combat. A complete military training was held up as essential, both because of the necessity of active fighting and for the knowledge of military requirements needed for the proper course of engineering operations.

Under the existing American army organization there are five battalions of engineers for each army division of 60,000 men. In Europe the ratio of engineers to infantry is 6%—double that here. If a trained force of 500,000 men was decided on for defense in this country, there would have to be about 1,200 officers, 8,000 noncommissioned officers and 28,000 enlisted engineers. Officers and noncoms., it was said, would have to be good technical men with adequate military training. There are now 248 engineer officers and 19,000 troops in the regular army, with 60 officers and 1,500 men in the National Guard.

Captain Robins described the work of the army engineer in action as having very few of the ordinary construction and municipal features. However, it is essentially only the engineering of civil life adapted to military necessities. The activities of all sorts of engineers are embraced in surveying, mapping, reconnoissance, trenching, tunneling, mining, sapping, lighting camps and battlefields, building and maintaining coast fortifications, keeping telephone, telegraph and wireless communication open (the work of the signal corps rather than the engineer troops), field bridge building, maintaining roads and bridges between railway heads and troops in the front line, construction and operation of railways in the danger zone, etc. The younger and more vigorous men would belong to the pioneer and pontoon field forces, while the older men might be expected to serve in the seacoast fortifications, along the lines of communication, on interior defensive works and on supply-depot and material-inspection details. For every such work adequate military training is an essential accompaniment of technical ability.

The remaining lectures will be by Capts. E. D. Ardery, R. T. Coiner and T. M. Robins, Corps of Engineers, U. S. A., and will take up more in detail: (1) Reconnoissance, mapping, surveying, photography; (2) field fortifications, sieges and demolitions; (3) sea-coast defenses and battlefield illumination; (4) roads, bridges, ferries, and fords; (5) camps and cantonments, general construction, public engineering works of a military nature; (6) railways under military control.

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Electrical Engineers Studying Institute's Functions

What is the proper function of the American Institute of Electrical Engineers? Does the rapid increase in technical knowledge and the increase in the number of specialists demand a readjustment of the society's organization and activities? Such were the questions propounded to the membership at the midwinter convention in New York on Feb. 8 by the paper of D. B. Rushmore, "The Institute and the Technical Committees."

For many years the institute had no technical committees at all; now it has 14—on power stations, transmission, railways, protective apparatus, lighting, telegraphy and telephony, marine work, electrochemistry, electrophysics, industrial power, records and appraisals, education, mining and the iron and steel industry. These committees have not been established in accordance with any general plan and do not subdivide the field of electrical engineering as was done in connection with the recent International Electrical Congress.

It was reported that the institute could not on present lines continue to supply the needs of the members for information along their special lines and that some modification must be brought about or there would be an increasing number of auxiliary societies of special interest. Twenty-eight societies were named as duplicating the work of the institute in part.

Some of the other important questions involved were as to the desirability of technical committees developing engineering handbooks on particular fields; the presentation of annual reports from technical committees outlining the special developments of the year in the several fields; the development of technical sections within the institute along lines of distinct division; bringing back to the institute a special organization covering special divisions of the electrical field; the possibility of a central organization wherein all engineering societies could be brought together; the definition of activities of the several engineering societies now overlapping; proper and permanent relationships between the institute and commercial organizations like the electric-light and railway associations. The paper presented no plan, made no arguments for particular plans, but stopped with the presentation of the problem.

The discussion showed the widest possible range of views, some holding that the institute should confine itself to the more scientific aspects, while others would make the institute's topics as broad as possible; some saw no danger in encouraging special societies. The president, J. J. Carty, reported that there were no data at all on present conditions or on the desires of the members, so that the problem could not yet be well defined. He urged the collection of data, just as in taking up any engineering problem.

Illuminating Engineers Hold Tenth-Year Celebration

The midwinter convention of the Illuminating Engineering Society, held at New York City, Feb. 10 and 11, was made a celebration of the tenth year in the life of the society. The opening session was devoted to a series of notable addresses by Hon. J. P. Mitchel, mayor of New York City; Dr. A. E. Kennelly, of Harvard University; Dr. C. C. Steinmetz, president of the society, of Schenectady; L. B. Marks, the first president of the society, of New York City; Prof. Hugo Muensterberg, psychologist, of Harvard University; C. R. Lamb, architect, of New York City; and Dr. F. P. Lewis, physiologist, of Buffalo.

These addresses reviewed progress in the many fields which improved lighting touches. Mr. Marks, in a historical review, showed how the membership had increased to over 1,500 in 10 yr., gathering in a harmonious aggregation electrical and gas engineers, architects, decorators, fixture designers and manufacturers, physiologists and psychologists. The society has printed some 8,000 pages of proceedings, covering all phases of the science and art of good lighting.

A notable feature of the convention was a banquet at which honorary membership was conferred on Thomas A. Edison. One evening session was given up to a lecture by W. d'A. Ryan, of Schenectady, the designer of the lighting features of the Panama-Pacific Exposition. A technical program was also presented.

ENGINEERING SCHOOLS

Ohio State University

Research professorships are to be established, according to a recent vote of the board of trustees on a suggestion of President W. O. Thompson. The research professors will be relieved of all, or nearly all, instruction duties and will follow research work in their special subjects for the benefit of the state. To begin with, five or six such professorships may be established, probably including one or two in engineering.

Ohio State University

A new postgraduate course in Public Health and Sanitation has been incorporated in the courses of study of the Ohio State University. The aim of the study is to prepare young men and women for public-health work in Ohio and elsewhere; to fit them to occupy positions as health officers, members of boards of health, secretaries, agents, or inspectors of health organizations, either official or voluntary. To do this, it is planned to give a groundwork of sanitary knowledge by instruction in the laboratories and by lectures.

University of Knoxville

The department of engineering has prepared a correspondence course in highway and bridge construction for county engineers. The course consists of 20 lessons, prepared by Prof. Corphul Fergus, and is supervised by Prof. Charles E. Ferris.

NOTES

A Conflagration in Bergen, Norway, destroyed a third of that seaport on the night of Jan. 16. The property damage is estimated at $15,000,000. The section of the city destroyed includes the business section, several hotels, a number of schools, the electric-lighting plant, etc.

Plans for Water-Works Improvement at Aberdeen, Wash., to cost about $400,000, are being made by L. D. Kelsey, city engineer. It is expected that there will be a 40-in. wood-stave supply conduit, that bids for this and the head works will be received during the coming spring and that the construction of this part nearly completed during 1916.

Alabama Water-Power Condemnation Statutes were declared constitutional by the United States Supreme Court on Jan. 24. The suit was brought by the Alabama Interstate Power Co., of Birmingham, to condemn certain lands on the Tallapoosa River. Justice Holmes stated that the objection that the purpose is not a public one is not valid, because "to gather the streams from waste" in order to produce and sell power is a public benefit.

The False Block-Signal Indication that caused the collision of a passenger and a freight train on the Nashville, Chattanooga & St. Louis Ry. near Cowan, Tenn., on Dec. 23, 1915 (see "Engineering News," Jan. 6, 1916, p. 45), has been investigated by the Division of Safety, Interstate Commerce Commission. A report has just been made by H. W. Belnap. At the point of the accident there is a siding controlled by electric three-position block signals. The parallel Western Union telegraph lines and the signal wires were being moved. A grounded signal wire and a cross with the telegraph lines are charged with responsibility for the foreign current that held the signal falsely at "clear." This is the first such accident reported to the commission.

A Bronze Memorial Tablet of the late George Westinghouse, founder of the numerous industries bearing his name, was presented to the Westinghouse Electric and Manufacturing Co. by the Veteran Employees' Association of that company at its third annual banquet, held on Jan. 29 in the Fort Pitt Hotel, Pittsburgh. This organization is three years old and is composed of men who have been in the employ of the company for 20 years or longer. About 450 were present at the banquet. President I. De Kaiser made the opening address and introduced the toastmaster, John E. Bonham. The memorial tablet is approximately 4x3 ft., made of solid cast bronze, and weighs 300 lb. It shows a true bas-relief likeness of Mr. Westinghouse and bears the inscription, "George Westinghouse, Master Workman, Inventor, Founder, Organizer, 1846-1914." It will be placed in the reception room of the East Pittsburgh works of the company.

Admission to an Engineering Society as a legal right was involved in a suit just decided in New York City. Nora Stanton Blatch brought suit against the American Society of Civil Engineers to compel her admission to the grade of associate member. Mrs. Blatch is a graduate from the civil-engineering course of Cornell University and was admitted to the society as a junior in 1906. Under the society's constitution a junior reaching the age of 32 years ceases connection with the society unless he has been previously transferred to a higher grade. According to the brief submitted by the attorney for the plaintiff, Roger Foster, Mrs. Blatch applied in 1912 for transfer to the grade of associate member, but her application was rejected, a resolution of the board being cited in connection with the application of another woman for admission to the society, in which the board expressed its opinion that the constitution of the society does not contemplate the admission of women. On Jan. 6, 1915, Mrs. Blatch again applied for transfer to the associate-membership grade, and she claims that a majority of the board voted in her favor. According to the society's constitution, election to membership is by letter ballot of the Board of Direction; and in such letter ballot at least 25 votes must be cast, and 3 or more

negative votes exclude from election. Mrs. Blatch's attorney based his chief argument on the claim that according to the constitution the above restriction applied only to election to membership and not to transfers from one grade to another, and that under the general corporation law a majority of votes in favor of the transfer was all that was required. The brief of the society's attorney, W. C. Runyon, declared that Mrs. Blatch's application for associate membership had been acted on in accordance with the society's constitution; and the judgment of a court should not be substituted for the judgment of the society's Board of Direction. The judge decided against the plaintiff, saying: "I know of no authority in this court to direct a private corporation to elect or admit any member."

PERSONALS

Mr. F. R. Perkins has been elected Engineer in Charge of Construction, Dallas (Tex.) Southwestern Traction Co.

Mr. B. S. Wathen, M. Am. Soc. C. E., Consulting Engineer, Dallas, Tex., has been elected Consulting Engineer of the Dallas Southwestern Traction Co.

Mr. R. D. Goodrich, City Engineer of Cheyenne, Wyo., has been appointed Manager of Municipal Public Utilities, under the Board of Public Works, of Ypsilanti, Mich.

Mr. S. E. Elmore, formerly Central Sales Manager of the Bucyrus Co., of South Milwaukee, Wis., has been made Superintendent of the Evansville plant of the company.

Mr. John T. Witt has been elected Chief Engineer of the Dallas (Tex.) Southwestern Traction Co. The company proposes to construct an interurban line from Dallas to Clebourne and Glen Rose.

Mr. George Hogarth, Assoc. M. Can. Soc. C. E., formerly Assistant Engineer of the Department of Public Works of Ontario, has been appointed Chief Engineer of the Department of Highways of the Province of Ontario.

Mr. Oscar E. Thomson, Consulting Mechanical Engineer, of Phoenixville, Penn., has been appointed Mechanical Engineer in the Hygiene and Engineering Division of the Pennsylvania Department of Labor and Industry. He succeeds Richard M. Pennock, Safety Engineer for the state insurance board.

Mr. DeWitt V. Moore recently resigned from the position of District Engineer of the Central District of the Division of Valuation of the Interstate Commerce Commission, with headquarters at Chicago, to specialize in valuation work in a consulting capacity. His offices are in the Lytton Building, Chicago, Ill.

Mr. William B. Bennett, M. Am. Soc. C. E., Consulting Engineer, has been appointed City Engineer of Niagara Falls, N. Y. Mr. Bennett was formerly connected with the Hydraulic Power Co., of that city. He will continue his practice as consulting hydraulic engineer in addition to the duties of his new appointment.

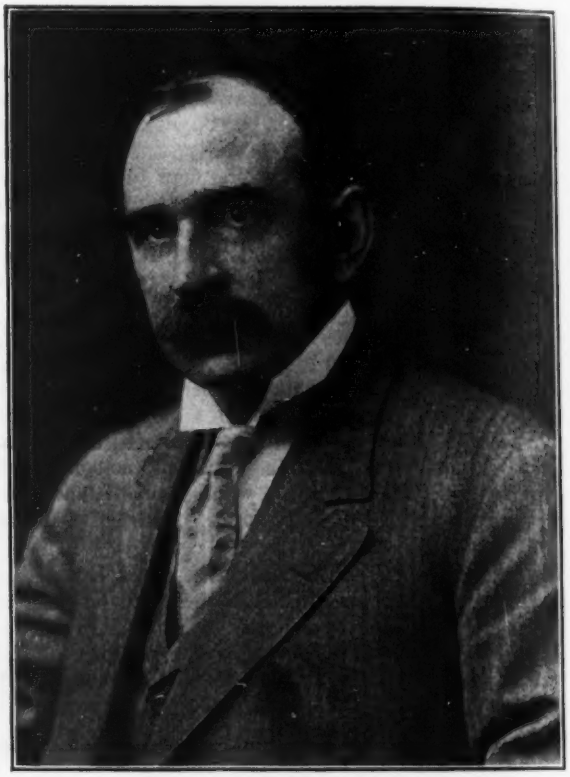
Mr. C. G. Elliott, M. Am. Soc. C. E., has become affiliated with the Harman Engineering Co., of Peoria, Ill., which corporation will hereafter be known as the Elliott & Harman Engineering Co. Mr. Elliott will be in charge of the Eastern branch office of the company, at 503 McLachlen Building, Washington, D. C., and will continue his practice as consulting drainage engineer.

Mr. Lucius T. Berthe, Assoc. M. Am. Soc. C. E., of Charleston, Mo., County Surveyor of Mississippi County, has been selected as engineer in charge of the proposed work of the new drainage district in the Dog Tooth Bend section above Cairo, Ill. Mr. Berthe has just completed improvements in Mississippi County representing an outlay of $1,500,000. The Dog Tooth Bend improvements are to protect over 20,000 acres of land from high waters and will also reclaim an extensive area of swamp land.

Messrs. Robert Spurr Weston, M. Am. Soc. C. E., Consulting Sanitary Engineer, and George Arthur Sampson, Assoc. M. Am. Soc. C. E., Principal Assistant Engineer to Mr. Weston, have formed a partnership under the name of Weston & Sampson for the practice of engineering. They will continue to occupy the offices at 14 Beacon St., Boston, Mass., where they have been for many years. Mr. William Wheeler, M. Am. Soc. C. E., will coöperate with the new firm, mainly in an advisory capacity. They will specialize in water-supply and purification, sewerage and sewage disposal and the disposal of municipal and factory wastes.

Mr. A. N. Johnson, M. Am. Soc. C. E., recently connected with the Bureau of Municipal Research of New York City, has been apointed Consulting Highway Engineer of the Association of American Portland Cement Manufacturers, with headquarters in the new offices of the association at 111 West Washington St., Chicago, Ill. Mr. Johnson is a graduate of Harvard University. He was at one time Third Assistant Engineer of the Massachusetts Highway Department and was State Highway Engineer of Maryland for seven years. He served in a similar capacity for eight years in Illinois and was for a year Chief Engineer of the United States Office of Public Roads.

Albert H. Scherzer, president of the Scherzer Rolling-Lift Bridge Co., of Chicago, and widely known in the engineering world in connection with the introduction of the bascule type of drawbridge, was killed, Jan. 28, by falling down an elevator shaft in the Monadnock Building, Chicago. The company has its offices on the sixteenth floor and keeps a number of its books and papers on the seventeenth floor, which is used only for storage and service purposes. A passage to the storeroom opens to the elevators, and here the part of the



ALBERT H. SCHERZER

shaft where Mr. Scherzer fell was closed only by a low hand rail. The place is dimly lighted. A few minutes previously Mr. Scherzer had obtained the key to the storeroom. As he was apt to be absent-minded or preoccupied, the assumption is that he in some way stumbled and fell over the rail. Mr. Scherzer was widely known in the engineering world for his development of the bascule type of drawbridge. He organized the present company in 1897 to introduce the rolling-lift bascule bridge, which had been invented in 1893 by his brother, William Scherzer, a consulting engineer of Chicago. When the Metropolitan Elevated R.R. wanted to build its bridge across the Chicago River it was found impracticable to use a swing bridge, as it was between the two existing swing-bridges at Van Buren St. and Jackson St. William Scherzer was consulted and designed the rolling-lift bridge, which was adopted; but he died before the completion of the bridge in 1895. Albert H. Scherzer realized the possibilities of this new type of bridge and patented it. In 1896 designs were made under his direction for different structures, including the Vernon Ave. bridge over the Harlem River at New York. He made a close study of bridge design, and when the company was organized he was prominent in its technical as well as in its commercial department. In fact, a number of the improvements and developments were due to his ideas and suggestions. There are now about 230 bridges of the Scherzer type in service or under construction, many of these being

notable structures and several of them being in foreign countries. Mr. Scherzer was particularly proud of the extensive and widespread use of his bridges. Of late years he had become specially interested in the matter of waterways and inland navigation and had given less attention to the bridge and to the affairs of the company. Albert H. Scherzer was born in Peru, Ill., in 1865. After going through the high school, he went to Switzerland and graduated from the Technical School at Zurich. In 1892 he graduated from the Union College of Law at Chicago, and then practiced law until his interest was attracted to the possibilities of the development of the bascule bridge. In 1902 he married Donna G. Adair, of Madisonville, Ohio, who survives him. They had no children.

OBITUARY

John Humphrey McCarthy, a railroad builder of national reputation, died at 76 years of age at Little Rock, Ark., on Feb. 10. Colonel McCarthy constructed the Missouri, Kansas & Texas; Atchison, Topeka & Santa Fé; Missouri Pacific and other roads.

John H. Gerrish, President of the Gerrish Dredging Co. and formerly Treasurer of the Eastern Dredging Co., of Boston, died at his home in Melrose Highlands, Mass., on Feb. 7, at 57 years of age. In his connection with the dredging companies mentioned Mr. Gerrish was engaged on a number of the larger engineering works about Boston, including the Charles River dam, one of the Commonwealth piers at South Boston and the Charles River embankment.

Walter Frank Carr, M. Am. Soc. C. E., Consulting Engineer and Manufacturers' Agent, of Seattle, Wash., died at his home in that city on Feb. 3, at 55 years of age. Mr. Carr formerly was Superintendent of the Track Department of the Chicago street railways and as Chief Engineer had charge of the construction of the Twin City electric system between St. Paul and Minneapolis. For 13 years he was also Chief Engineer of the Falk Co., of Milwaukee, Wis. He was a graduate of the Massachusetts Institute of Technology, class of 1884.

Stevenson Towle, M. Am. Soc. C. E., for 18 years Chief Engineer of the Department of Sewers of New York City, died at Mamaroneck, N. Y., on Feb. 14, in his seventy-ninth year. At various times he was also Park Commissioner, a member of the first Rapid Transit Commission, a member of the commission that laid out Long Island City and Consulting Engineer of the Department of Health, Department of Pavements and the Consolidated Gas Co. He was born at Prince Bay, Staten Island, N. Y., and was a graduate of the College of the City of New York.

William Jasper Nicolls, M. Am. Soc. C. E., engineer and writer, died suddenly at Philadelphia on Feb. 14, at 63 years of age. He was born at Camden, N. J., and received his education in the Hill School at Pottstown, Penn. In 1873 he was appointed Assistant Engineer of the Reading Ry. and two years later became Chief Engineer of the Pennsylvania Steel Co. He was appointed in 1880 Chief Engineer of the Long Island R.R., which position he held for two years, and then engaged in the private practice of mining and civil engineering. He studied and wrote extensively on the subjects of coal mining and railroad construction.

ENGINEERING SOCIETIES

COMING MEETINGS

NINTH CHICAGO CEMENT SHOW.
Feb. 12-19. First Infantry Armory and Coliseum. Secy., R. F. Hall, 208 South La Salle St., Chicago, Ill.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 14-15. Annual meeting at New Haven. Secy., J. Frederick Jackson, Chamber of Commerce Bldg., New Haven, Conn.

BUILDING INSPECTORS' CONFERENCE.
Feb. 14-15. In Chicago. Secy., S. J. Williams, Madison, Wis.

AMERICAN CONCRETE INSTITUTE.
Feb. 14-17. Annual convention in Chicago. Secy., John M. Goodell, 1418 Walnut St., Philadelphia, Penn.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 14-17. Annual meeting in New York City. Secy., Bradley Stoughton, 29 W. 39th St., New York City.

ASSOCIATION OF ONTARIO LAND SURVEYORS.
Feb. 15. Annual meeting in Toronto, Can. Secy., L. V. Rorke, Parliament Building, Toronto, Ont.

SECOND NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.
Feb. 15-18. At Chicago. Secy., J. P. Beck, 208 South La Salle St., Chicago, Ill.

IOWA ENGINEERING SOCIETY.
Feb. 16-18. Annual meeting at Des Moines. Secy., J. H. Dunlap, Iowa City, Iowa.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.
Feb. 16. Annual meeting in Boston. Secy., N. W. Gifford, 38 Central Sq., East Boston, Mass.

AMERICAN CONCRETE PIPE ASSOCIATION.
Feb. 17-18. Annual convention in Chicago. Secy., E. S. Hanson, 538 South Clark St., Chicago, Ill.

IDAHO SOCIETY OF ENGINEERS.
Feb. 21-23. Annual meeting in Burley. Secy., I. F. Shaffner, Boise, Idaho.

ARKANSAS ENGINEERING SOCIETY.
Feb. 22-23. Annual meeting at Helena. Secy., W. J. Parkes, Citizens Bank Building, Pine Bluff, Ark.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 28 to Mar. 3. Annual convention in Pittsburgh. Secy., E. L. Powers, 150 Nasau St., New York City.

ENGINEERING SOCIETY OF WISCONSIN.
Feb. 25-26. Annual meeting in Madison. Secy., L. S. Smith, Madison, Wis.

Iowa State Drainage Association will hold its annual meeting in Fort Dodge, Feb. 24 and 25. The secretary is M. F. P. Costelloe, Ames, Iowa.

Association of American Portland Cement Manufacturers has removed its headquarters from Philadelphia to Chicago, where offices have been established at 111 West Washington St.

American Institute of Consulting Engineers elected on Feb. 2 the following officers for 1916: President, Dr. Elmer L. Corthell; vice-president, George Gibbs; secretary and treasurer, F. A. Molitor.

Western Society of Engineers has elected as secretary E. N. Layfield, M. Am. Soc. C. E. He was made assistant secretary about a year ago and has been acting secretary since the death of J. H. Warder.

Canadian and International Good Roads Congress—The third Canadian Road Congress will be at Montreal, Can., Mar. 6 to 10. It is expected that delegates will attend from all the provinces of Canada and from the United States.

Connecticut Society of Civil Engineers held its thirty-second annual meeting in New Haven, Feb. 15 and 16. At the business session ten papers were presented, dealing with water-supply, sewage-disposal, Federal valuation of railways, telephony, river and harbor improvements, electric street-railway maintenance and bridge construction. The secretary is J. Frederick Jackson, New Haven.

Idaho Society of Engineers holds its seventh annual convention in Burley, Feb. 21 to 23, with headquarters at the National Hotel. A luncheon will be held on Monday, immediately following which President Dibble, Colonel Miller, mayor of Burley, and F. A. Wilkie, state engineer, will speak. Some of the papers to be read are "The Camera and the Engineer," "Phosphate Deposits in Southern Idaho," "Irrigation Pumping and Power Rate Therefor," "Hydrometric Data and Practice on the Minidoka Project," "Silting of Canals and the Minidoka Drainage System" and "Surveys of Overflowed Lands in Arkansas." The annual banquet will be held in the evening at the National Hotel. The next morning there will be an inspection trip to the Minidoka project. The chairman of the entertainment committee is J. S. Longwell.

New England Water-Works Association held a meeting at the Hotel Brunswick, Boston, on Feb. 9. Following the usual luncheon, a business meeting was held, at which it was voted not to collect an initiation fee from members of the American Water-Works Association who join the New England Water-Works Association during 1916. This action was like that taken last year, which resulted in a large increase in the membership of the association. It was also voted that a committee of the association be appointed to confer with the National Board of Fire Underwriters on grading the insurance rate. The causes of explosions of domestic boilers were discussed at considerable length, and tests were made on a number of different makes of release valves, in order to demonstrate their operation. The paper on the "Progress of Water Sterilization in Maryland," by Robert B. Morse, Chief Engineer, and H. L. Hall, Assistant Chief Engineer, Department of Health, Baltimore, Md., was read by C. M. Saville in the absence of the authors. A committee on meter rates, which presented a progress report in 1914, made a final report at this meeting. After some discussion it was voted that the report be printed and sent to members, in order that the subject might be more fully discussed at a later meeting.

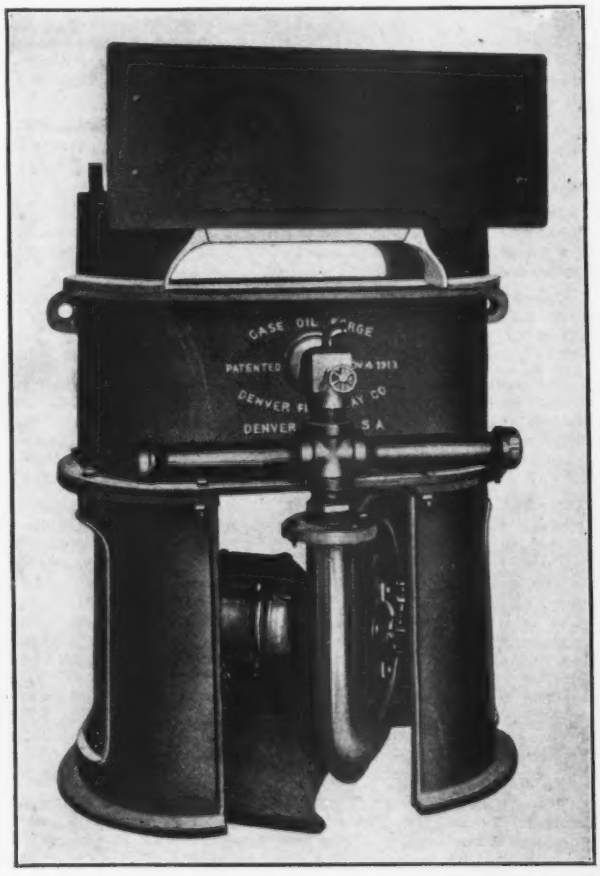
New Jersey Sewage-Works Association—Acting on a suggestion from Clyde Potts, a member of the New Jersey State Department of Health, 16 men from as many towns met at Trenton on Jan. 28 and organized the New Jersey Sewage-Works Association. John R. Downes, of Plainfield, N. J., was elected president, and Fred T. Parker, of the Atlantic City Sewerage Co., was elected secretary and treasurer. Besides an annual meeting there will be two meetings a ar at different sewage-disposal works in the state.

Appliances and Materials

Low-Pressure Oil-Burning Forge

A forge in which drill steels can be heated, which can be used for miscellaneous small blacksmithing, which burns fuel oil and is supplied with low-pressure air from an electric-driven blower underneath is being manufactured by the Denver Fire Clay Co., of Denver, Colo.

The opening to the forge is designed to hold drills or puncher bits and has a heating capacity, when operated steadily, of nine 1¼-in. steels per min. The forge is almost noiseless, because the air used is at a pressure of only about 6 oz. The fan is operated by a 1½-hp. motor. The manufacturer states that in a shop in which machine sharpeners are employed, it will be found that this 20-in. forge, equipped with a Case burner, can keep two sharpeners supplied with heated steels.



NEW CASE OIL FORGE FOR DRILL STEELS

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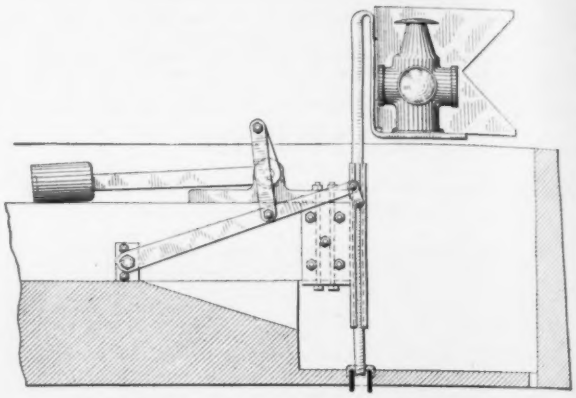
Acid-Resisting Alloy

A new formula for an acid-resisting alloy has been worked out by Prof. S. W. Parr, of the University of Illinois, Urbana. The composition is reported to be: Copper, 6.42%; manganese, 0.98%; silicon, 1.04% tungsten, 2.13%; nickel, 60.65%; aluminum, 1.09%; iron, 0.76%; chromium, 21.07%; molybdenum, 4.67%; boron and carbon not determined. The properties are reported to be due to "careful proportioning of electro-positive and electro-negative metals."

Disappearing Switch Light

A new switch-lamp stand for sidings from main-line tracks is being made by E. F. Hartzell, of East Bakersfield, Calif. As shown in the accompanying sketch, a concrete or masonry pit for the lamp to drop into is made at the switch stand. The lamp and target are mounted on a rod which moves vertically in a guide on the switch-stand tie. The lamp is set to rise out of the pit when the switch is thrown for the siding. A steel pit cover may be added to the target to keep out rain. It is reported that this type has been used with satisfaction by the Southern Pacific Co., at Bakersfield, Calif.



HARTZELL DISAPPEARING SWITCH LIGHT

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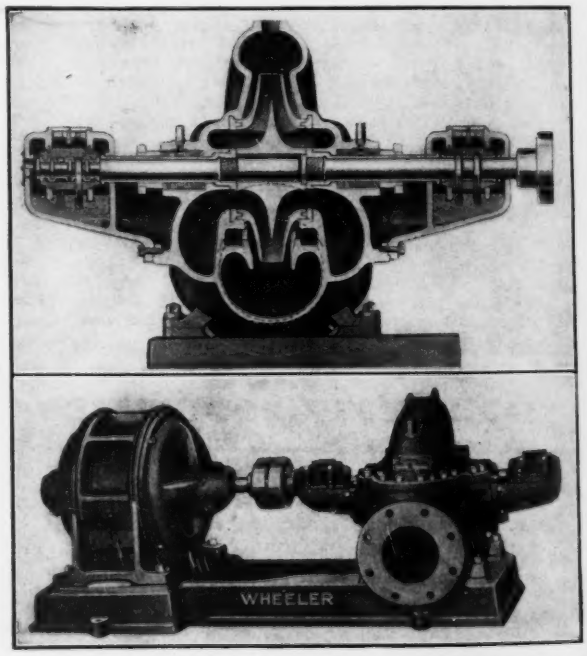
Small Centrifugal Pump for Tank Service

A small motor-driven centrifugal pump is now being built by the Wheeler Condenser and Engineering Co., of Carteret, N. J. The figure shows the general features of the pump. It has a two-part divided casing, with both suction and discharge nozzles in the lower half. The impeller is of the closed double-suction type, protected by labyrinth wearing rings. The shaft is protected from the water by bronze sleeves that screw on the shaft and extend through into the bearing-bracket boxes. Bearings are of the ring-oiled type. There is a ring-oiled thrust bearing which the manufacturer claims is not commonly found in double-suction single-stage pumps. The pump shown is intended for tank or standpipe service.



SMALL MOTOR-DRIVEN PUMP FOR STANDPIPE SERVICE